HAULAGE AND WINDING APPLIANCES USED IN MINES

CARL VOLK

8/6 m

HAULAGE AND WINDING APPLIANCES

HAULAGE AND WINDING APPLIANCES

USED IN MINES

BY

CARL VOLK

INSTRUCTOR AT THE COLOGNE MUNICIPAL SCHOOL OF MACHINE CONSTRUCTION

WITH 6 *PLATES AND* 155 *FIGURES IN THE TEXT*

LONDON

SCOTT, GREENWOOD & CO.

19 LUDGATE HILL, E.C.

NEW YORK

D. VAN NOSTRAND COMPANY

23 MURRAY STREET

1903

PREFACE.

During the period when the Author filled a position on the teaching staff at the Imperial and Royal Mining Academy, Leoben, he for several years enjoyed the advantage of serving under Julius von Hauer, whose great skill as a teacher was shown by the excellent manner in which he succeeded in making his listeners well acquainted with the extensive field of mining machinery by his succinct method of instruction.

At the time the Author was imbued with the idea of treating in a brief manner the subjects dealt with in Von Hauer's large work on winding engines; and the present work is the outcome of that idea, though its purpose is of a more modest character than that of the master.

The present work is intended for students in mining schools, young technicists desiring to extend their knowledge in this special direction, for the mine manager wishing to gain a comprehensive view of the complex subject, and so on. In all cases, however, a certain general knowledge of machinery is pre-supposed; extensive descriptions are avoided, and the drawings

merely briefly explained. The constructive side of the question has naturally had to be omitted altogether, though the special requirements entailed by the conditions of pits and shafts are always brought into prominence.

CARL VOLK.

COLOGNE, GERMANY,
1901.

CONTENTS.

CHAPTER I.

ROPES.

THREE classes of ropes are used in mine haulage, namely, wire, hemp, and aloe-fibre rope.

I. WIRE ROPE,

or cable, is used for raising loads, for transmitting movement in underground haulage, as the carrier in rope tramways, as guiding rope for pit cages, etc. Some wire ropes are of circular section, others rectangular (flat ropes).

(*a*) **Round Ropes.**—In the manufacture of winding ropes a suitable number of wires are laid together to form a ply, and several of these are then plaited together to make a rope. For specially flexible cables and lift ropes the plies are first united into strands and these again into the rope. The number of wires used is 36-180, or, for ropes to be used in conjunction with very small pulleys, 120-294. A core of hempen cord, or annealed iron of circular or oval section, is often placed in the centre of the plies and of the rope; and such ropes are far more flexible than usual, though on the other hand they are much more bulky, and are easily crushed when several layers of the rope are wound one on the other. In cross-laid ropes the twist of the plies forming the rope is in the opposite direction to that of the wires in the plies themselves; hence, if the plies show a left-handed spiral twist, the spiral position they assume in the rope is right handed. This arrangement renders the rope more flexible, and diminishes its tendency to axial rotation under the influence of a load. On the other hand, the wires form numerous ridges on the periphery of the rope, and are there sub-

jected to strong flexion, so that for certain purposes, where the rope is exposed to mechanical wear by surface friction and abrasion (underground haulage, wire tramways, etc.), it is preferable to have the twist of the separate wires and plies running in the same direction. A somewhat different arrangement is that shown in Fig. 1, representing the Felton & Guilleaume "patent closed" rope that has latterly come into use for haulage and wire tramway purposes. As can be seen from the drawing, this rope consists of a wire core surrounded by several concentric layers of shaped wire, wound alternately right and left handed, the section of the wires being such that no interstitial spaces are left between them. The wires in the outer layer fit into each other, and, by a special arrangement of the spinning machine, are given a greater tension than those inside, the result being that any fracture, arising in use, becomes apparent in

FIG. 1.

the outer layer first, and not in the inner, unseen portion. By the abolition of the hempen core and the useless interstitial spaces, this rope is lighter and much thinner than others of equal strength; consequently, a greater length of rope can be wound on the same drum, and greater depths can be attained without necessitating any alteration of the drum. On the other hand, these ropes are more susceptible to injury from kinking in the tail rope, defective coiling and winding; and as the closed construction prevents the protrusion of broken ends at the surface, incipient damage is more difficult of detection, and the rope therefore requires far more careful inspection.

Tapered Rope.—In very deep shafts the weight of the rope itself lays a heavy strain on the upper portions; but as the influence of this weight decreases downwards, the rope can be reduced in sectional area in the lower portion (tapered), preferably, in the case of round ropes, by decreasing the number of wires used. These

ropes are much lighter than those of constant section, but are by no means extensively used, although they have been found to answer well in certain cases.

Kind of Wire Used.—Charcoal iron and Bessemer steel are seldom employed, except for tramway and guide ropes, or in cases where heavy underground haulage ropes are required. The most usual material is crucible steel, with a breaking strain of 170,000 to 250,000 lb. per sq. in., greater strength being required only in cases of very deep pits and heavy loads. The extensibility of this wire is smaller, it is more susceptible, and requires a large coiling radius.

Calculating the Strength of Rope Required.—The permissible amount of strain on ropes is generally fixed by administrative regulations. The usual plan of selecting rope is by taking the tensile strength quoted in the makers' catalogues and allowing a margin of safety, 6- to 8-fold in the case of goods and 10-fold when passengers (*e.g.*, miners) are in question; the weight of the rope itself must also be taken into consideration, and the winding drum should be of larger diameter than given in the makers' tables. It should be noted that, in consequence of dynamic influences, the strain on the rope is occasionally far higher than that corresponding to the weight of the load.

Attaching Rope to Load.—For the purpose of attaching the rope to the load, the former must be looped at the end. Where the strain is comparatively small, as in the case of horizontal haulage, a simple loop will be sufficient, the end of the rope being turned back on itself for a distance of 12-20 ins., and fastened by tightly lapping it with wire, or by means of a clamp. A suitably curved iron ring is inserted in the loop to protect the wire.

Fig. 2 shows the Felton & Guilleaume friction clamp, in which the loop is enclosed by strong iron plates at each side, and the ends held by additional clamps. The strong flexion of the rope in forming the loop always sets up unequal tension in the end parts of the rope; and, on this account, it is preferable to form the support for the load by loosening and bending the individual wires, or spreading the end out conically by driving in a dowel, the whole being then fixed in a previously superimposed conical bush,

by means of a hard lead casting. The remaining connections are attached to the bush in question (Fig. 37). This method, however, is attended with the risk of the wire getting loose in the lead, and the whole rope drawing out of the bush. (In Fig. 37 the steel sleeve is made in two parts for convenience in mounting.)

For attaching loads otherwise than at the end of the rope the Baumann clamp (Fig. 3) can be recommended. In this case a steel bush, divided into three parts and filled with a cast metallic

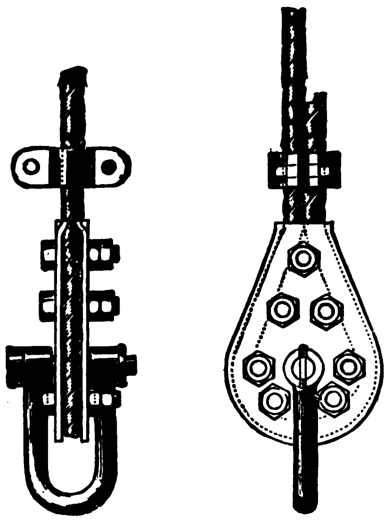


FIG. 2.

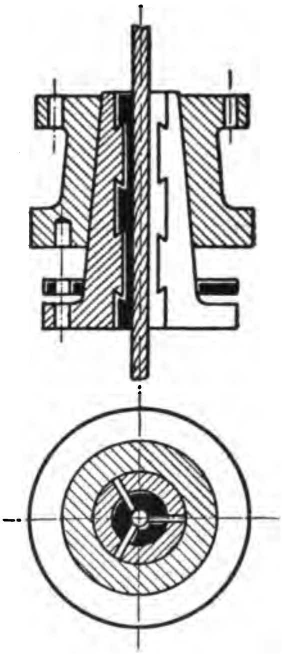


FIG. 3.

alloy, is pressed tight against the rope by an outer collar with tapered bore. The cage is supported on the collar, either direct or by means of chains, the narrow flange being utilised for mounting.

(*b*) **Flat Ropes.**—These consist of several (6-8 or 10) strands of round rope placed side by side and connected together by rivets of lenticular section, or, better still, by interwoven wires. The individual strands are usually four-ply, and alternately of right- and left-handed twist. Being thinner than round ropes of equal strength, they allow of a smaller radius of curvature in winding. Their advantages and

defects will be detailed when we come to speak of drums. The loop can be formed as in Fig. 4, or as in Fig. 2, the rope being laid round a pear-shaped pulley, and the end clamped to the main portion.

Since the practice of conveying the miners to and from the pit in cages has become the almost universal custom, greater attention than ever has to be bestowed on the careful testing of winding ropes, and in many parts is rendered obligatory by law. To detect broken wires the rope is allowed to pay out very slowly, and a wisp of

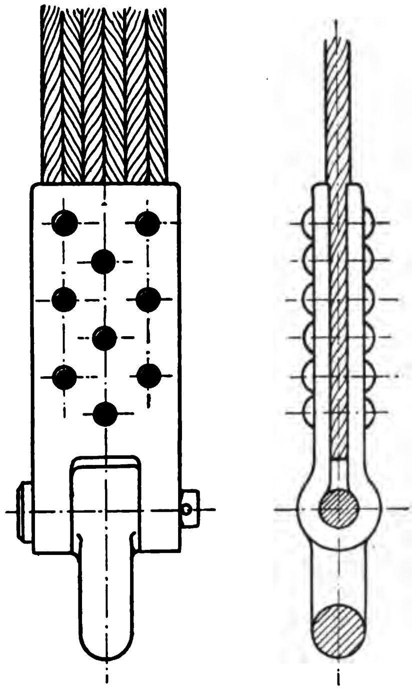


FIG. 4.

hemp is held against it; and every three or four months a length of two to three yards is cut off the tail end of the rope, and the individual wires tested for breaking strain, extensibility and flexibility.[1] The latter test is particularly important, since, while there is little alteration in the tensile strength, the brittleness increases and causes breakages. It is also good to grease the rope well,

[1] In tying the end up again, this length is drawn from the reserve coils on the drum (see p. 56). This proceeding is advantageous, as changing the part of the rope exposed to prejudicial strain on the drum at the commencement of winding.

especially when exposed to acid pit water; also the loop and that part of the rope which is between the head pulley and the drum when the cage is in its lowest position. The grease used—mixtures of tar, pitch, tallow, oil, etc.—must be free from acid, and sufficiently consistent to refrain from dripping under the influence of the (often high) temperature of the shaft.

2. Ropes of Aloe Fibre.

Flat ropes are made from the fibre of *Agave Americana* to carry loads not exceeding 1000-1140 lb. per sq. in., and to wind on drums of a diameter 20-40 times the thickness of the rope. As these drums are far smaller than can be used for wire rope, aloe ropes are preferred (especially in Belgium) for many purposes, *e.g.*, moderate depths, compensating pulleys, etc. For depths exceeding about 1,000 ft. these ropes must be tapered.

CHAPTER II.

HAULAGE TUBS AND TRACKS.

(*a*) THE TRACK.

THE track consists of rails and sleepers; the former, of the Vignol type, being made of ingot steel ; the sleepers (mostly transverse) of oak, or, where this is difficult to procure, of beech, larch, pine, etc., iron sleepers being more rare. Longitudinal sleepers are only used in exceptional cases, for instance, where the rope has to be carried long distances on the floor of a haulage road and below the level of the track.

Dimensions of Rails.—For convenience in lowering into the pit and handling there the length should not exceed 16-22 ft. The sectional area is calculated in the same manner as for girders on two supports, but with a larger margin of safety, since, apart from any accidental excess over the contemplated load, heavy rails are advantageous, as enabling the load to be increased. Stronger and firmer connections are used, the track is more durable, wears less and requires less repair. The dimensions of the rails are: height, $2\frac{1}{4}$-$3\frac{1}{4}$ ins.; weight, 11-25 lb. Rails over $17\frac{1}{2}$ lb. are strong enough for light locomotives.

Wooden Sleepers.—These measure $3\frac{1}{2} \times 4$ to $4\frac{1}{2} \times 6$ ins., and are laid at distances of 24-32 ins. apart. They are usually steeped (impregnated) with zinc chloride, oil of creosote, or by the Hasselmann process. This treatment, however, does not increase their life to such an extent as in surface railways. On the other hand, it is found highly advantageous to bed the sleepers in broken stone, gravel or slag. To fasten the rails in position hooked spikes are used, three to each sleeper (two outside, and one inside, the rail). In power haulage these spikes are occasionally replaced by screw-

bolts, and bed-plates are laid under the rails at the curves, up-gradients and switches. The joints are placed between the sleepers (Fig. 5). Rabbeting the sleepers below the rail foot, in order to give the rail an inward pitch, shortens the life and is better omitted.

Iron Sleepers.—These are still seldom used, though very little

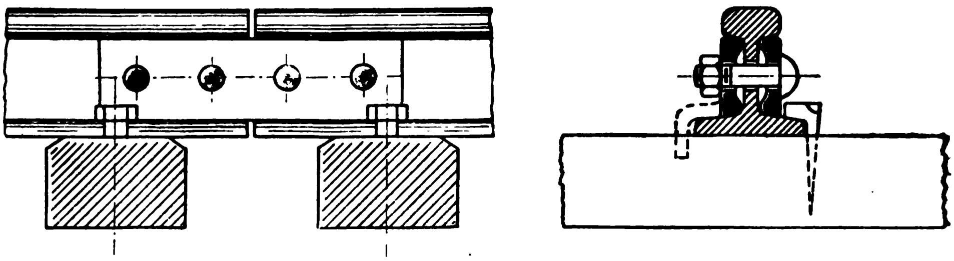


FIG. 5.

dearer than good wooden ones; but it is only when they are of the best quality and well looked after that they are preferable to the latter. The usual profiles for iron sleepers are shown in Fig. 7, and the method of fastening the rails on them is illustrated in Fig. 6.

Rail tracks should be laid with care, templets being provided for setting the rails the proper distance apart, etc.; the roads must

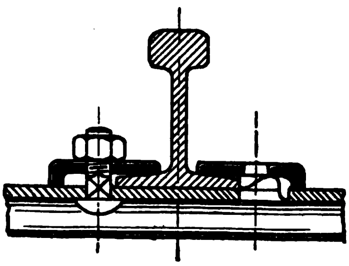


FIG. 6.

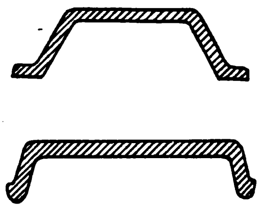


FIG. 7.

be carefully inspected and cleared, especially with a floor inclined to creep; and water must be drained off in serviceable gutters. The width (gauge) of the track, measured inside the rail heads, is 18-32 ins., and the outside measurement on the flanges of the tub wheels must be $\frac{1}{2}$-$\frac{3}{4}$ of an inch less. With narrow gauge smaller radii of curvature, turn-tables, etc., may be used, but the stability of the tubs is low.

In curves the track must be widened a little by setting the inner rail $\frac{1}{2}$-$\frac{3}{4}$ in. farther out, and at the same time the outer rail must be raised by one-tenth to one-twentieth the width of the track; the higher the speed and the sharper the curve, the more will the outer rail need raising. In mechanical haulage, guide rails are frequently provided at the curves to prevent the tubs running off the line.

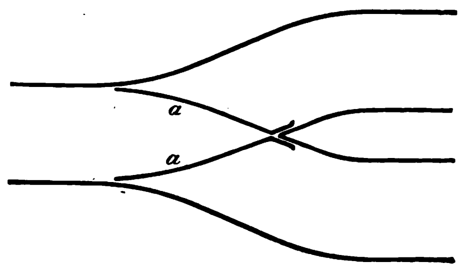


FIG. 8.

Since in running round curves the outer and inner wheels have different distances to travel, various methods have been proposed for the prevention of attrition :—

1. *Loose Wheels on a Stationary Axle* (Fig. 17).—This arrangement entails a great deal of wear in the hub journals.

2. *Loose Axle with One Loose Wheel.*—In this case the wear

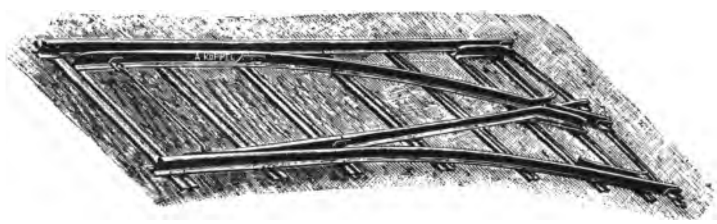


FIG. 9.

on the hub of the loose wheel is not so great, since merely the relative rotation between the hub and the axle, running in the same direction, comes into play.

3. *Conical Wheel Rims* (taper $\frac{1}{10}$-$\frac{1}{20}$).—This makes the tubs press against the outer rail when passing round curves, and consequently the outer wheel travels on a more extensive periphery than the inner one.

Fig. 11.

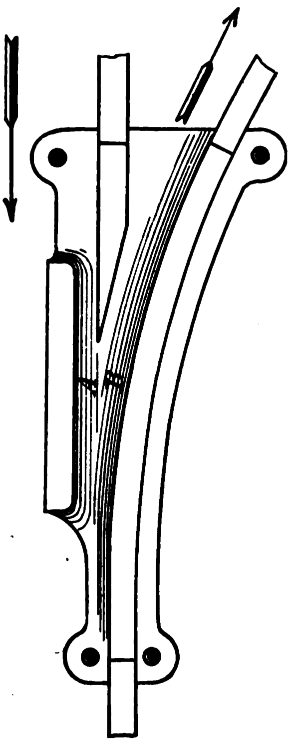


Fig. 10.

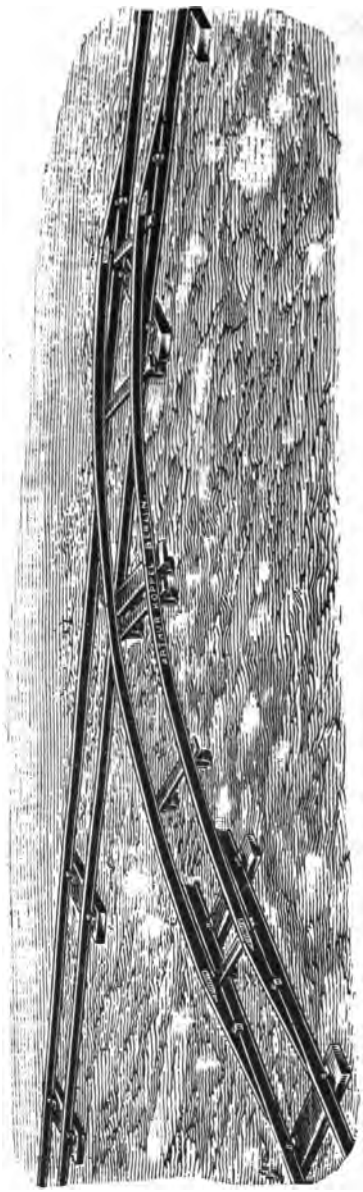


Fig. 12.

The radii of curvature should be selected as large as possible, *i.e.*, over 90-120 ft. True, in the pit, one is sometimes obliged to have curves as sharp as 30 ft. radius, and even less; but very sharp curves may often be advantageously replaced by turn-tables.

Switches.

1. **Fixed Switches.**—Where tubs have to be hauled singly, whether by horse or hand labour, the switch rails, *a* (Fig. 8), may be

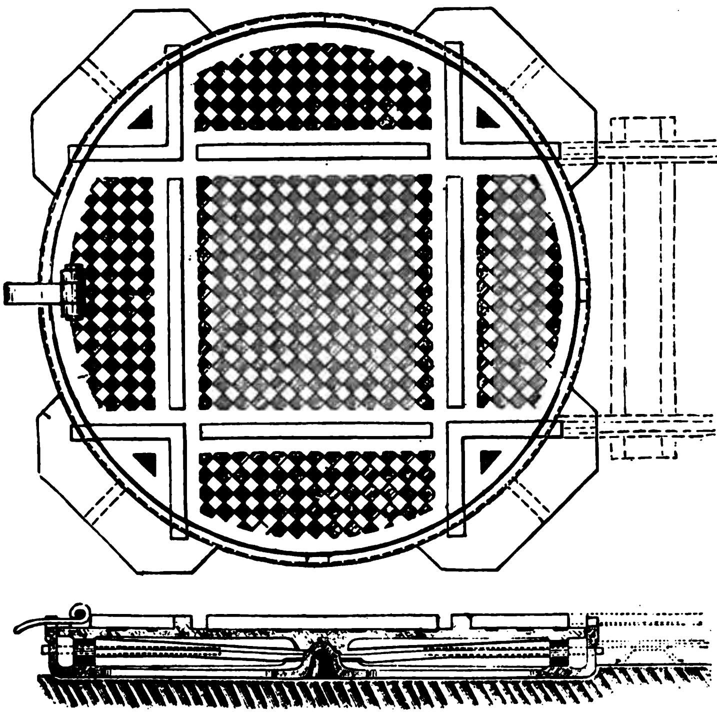


FIG. 13.

entirely omitted, plates of iron, over which the tubs run on the wheel flanges, being inserted between the outer rails.

2. **Adjustable Switches.**—(*a*) *Closed* (*Point*) *Switches* (Fig. 9).—The switch points are fastened together, and worked by the foot or a switch lever. Where the switching on to a branch is always in the same direction, *e.g.*, towards the right, then only one movable point is needed, in this case the left. These switches may be made automatic by fitting them with a spring or weighted

cord to press the point against the rail, and keep the one track always closed to tubs travelling in one direction, whilst those coming along that track in the opposite direction simply push open

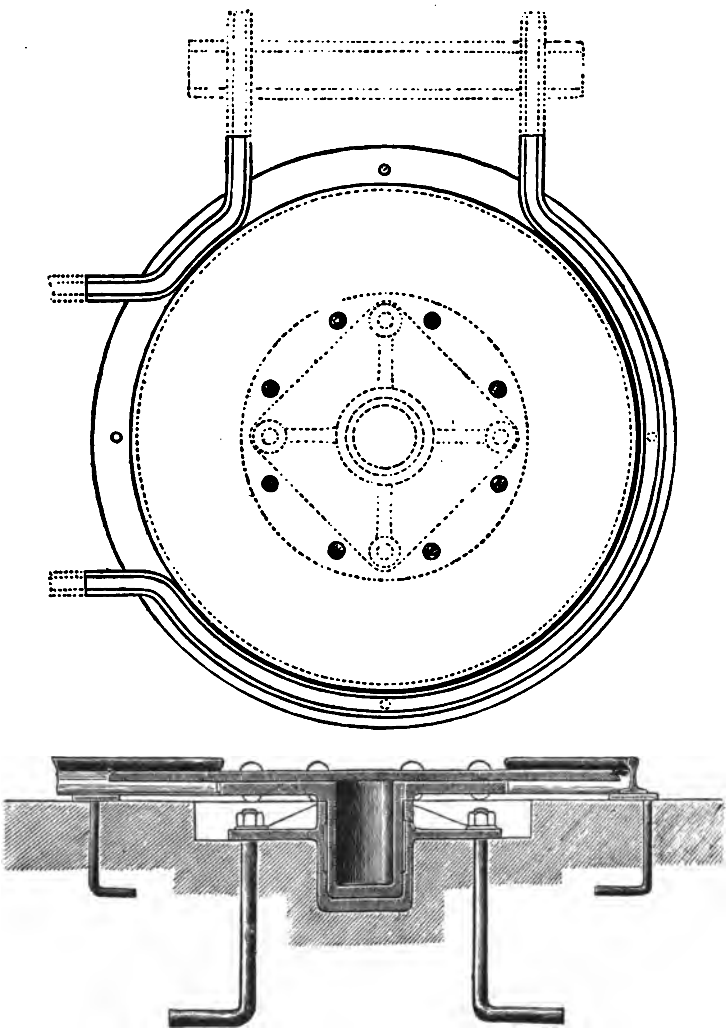


FIG. 14.

the movable point. The arrangement needs no pointsmen, but is liable to get out of order.

The same purpose is served by the plates shown in Fig. 1C, the slightly shaded portions of which are bevelled, A being a little higher than B. At this point the tub is running on the wheel

flange, and, when coming from the left, is switched off towards the right.

(*b*) *Open Switches* (Fig. 11).—These are easier to clean, but more liable to throw tubs off the line in consequence of wrong placing. They are seldom used for single-flange wheels and light work.

(*c*) *Climbing Switches* (Fig. 12) are very convenient for temporary branch lines.

Turn-plates and Turn-tables.—Several types are shown in Figs. 13-15, but turn-tables readily become choked up with dirt and then unworkable, so are not well adapted for pit use.

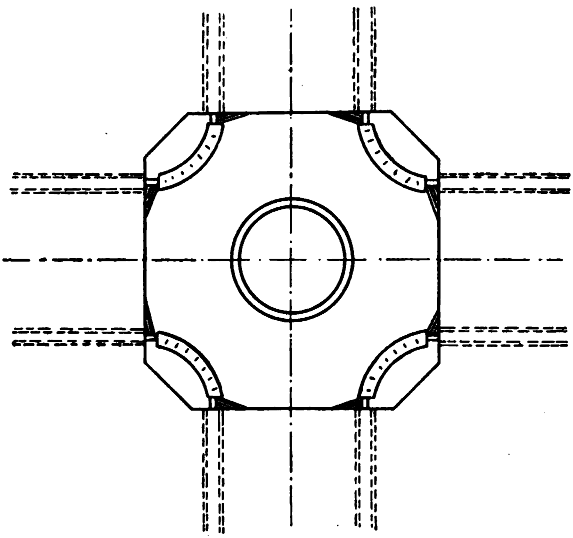


FIG. 15.

(*b*) THE TRUCKS.

Force of Traction for Drawing the Trucks.

No accurate calculation of the force of traction for trucks is possible, the values for rolling and journal friction being dependent to such a great extent on the careful construction of the rolling stock, condition of the track and tubs, and the lubrication. Generally the force of traction ranges between 0·8 and 2 per cent. of the total load, the average being 1 per cent. The resistance is generally

smaller in proportion as the wheels are larger and the journals smaller. In definite instances the actual force can be measured direct by means of a dynamometer. For tracks running on a gradient $\angle a$, the force of traction, Z, per tub is calculated for a given weight, A, from the relative gravitation and the friction corresponding to the normal pressure. Hence $Z = Q \times \sin a + Q \cos a \times f$ (this latter factor, f, being 0·01-0·02). For downhill haulage on slight gradients, the force is $Z = (Q \times \cos a) f - Q \times \sin a$; and where the angle a is greater, and the tubs run down of themselves, they descend with a force that can be determined from the formula $Q \sin a - (Q \cos a) f$. Whenever possible the track should be laid so that the full tubs traverse a down grade of 5-6 in 1,000, the empties having to overcome a similar resistance in ascending. The gradients for automatic inclines range from 10 to 12 in 1,000. In curves the force of traction is increased by 20-30 per cent. above the calculated value. For horse traction the most favourable gradient is 4-8 in 1,000. When hand labour is used it is advisable (at least up to distances of 200 yds.) to let the full tubs run downhill of themselves (braked if necessary) to the haulage road, so that the only labour required is for pushing the empties back up again; the gradient varies from 10 to 15 in 1,000. The maximum gradient for uphill traction by hand or horse labour may be fixed at 50 in 1,000. Other criteria besides the strength of the putters affect the weight of the tubs; for instance, very heavy tubs entail a waste of energy and time in turning on the turn-plates and in setting them back in place when off the line; furthermore, small tubs can be passed through narrow gates and down narrow inclines without trouble. Unless local conditions necessitate deviation, about 18 cwt. may be taken as a good average tub load for ore, and 12 cwt. for coal. The general dimensions of tubs are: Height above rails, 3-4 ft.; width, 24-32 ins.; weight, 45-55 per cent. of the weight of the load.

Details of Tubs.—The wheels are mostly single-flange solid wheels, of steel or hard cast-iron, well annealed, the rim tapered, and measuring 2-2½ ins. across, or double the width of the rail heads, in order that both wheels may properly cover the rails in running

round curves. Double-flange wheels are sometimes used in inclines, to enable simpler, automatic switches to be employed. Wheel diameter, 12-18 ins.; larger wheels are advantageous, but increase the wheel base and the height and weight of the tubs. The wheel base should not exceed the wheel diameter by more than $1\frac{1}{2}$-$3\frac{1}{2}$ ins., and must be reduced to a minimum in the case of tracks with sharp curves. An exception is afforded by the case of tubs drawn by an overhead rope, which are liable to run off the line often unless the wheel base is lengthened; and tubs for use in inclines are too easily tipped over when the wheel base is small.

The wheels are either mounted on loose axles or run loose on fixed axles. In the former case they are fastened in place by narrow transverse keys, only one wheel, however, being usually fixed in this way, the other running free. On that end the axle is fitted with a cap or nut and cottar, or a key is pushed in laterally in such a manner as to fit in an annular groove in the axle, and thus prevent the wheel from slipping off sideways though not from turning round.

The proper mounting and greasing of the wheels and axles is a very difficult matter, and the tubs suffer considerable damage from concussion, careless handling, dust, damp, etc. If the tubs do not have to pass over a tippler, and especially when the bearings can be placed outside the wheels, it is advisable to fit them with grease boxes, like those on railway trucks, with bottom oiling by means of felt pads.

For tubs that have to be tipped, nothing is better than the simple bearing, open underneath. When these are used, greasers are provided at intervals in the haulage road, consisting of roller brushes or elastically mounted discs that dip into an oil trough and apply a little grease to the axles of every tub that passes over them.

The most popular form at the present time is the tubular bearing, in which the entire length of the axle is surrounded by a sleeve of cast-iron or cast-steel. The portion forming the actual bearing is often filled up with composition. To diminish the waste of oil and at the same time keep dust out of the surfaces in sliding contact,

several patent devices have been introduced, notably those of Halmay (Fig. 16), with sliding cover, and Franz (Fig. 17), the latter being packed with rubber rings.

Where the rolling stock is extensive, some special means must

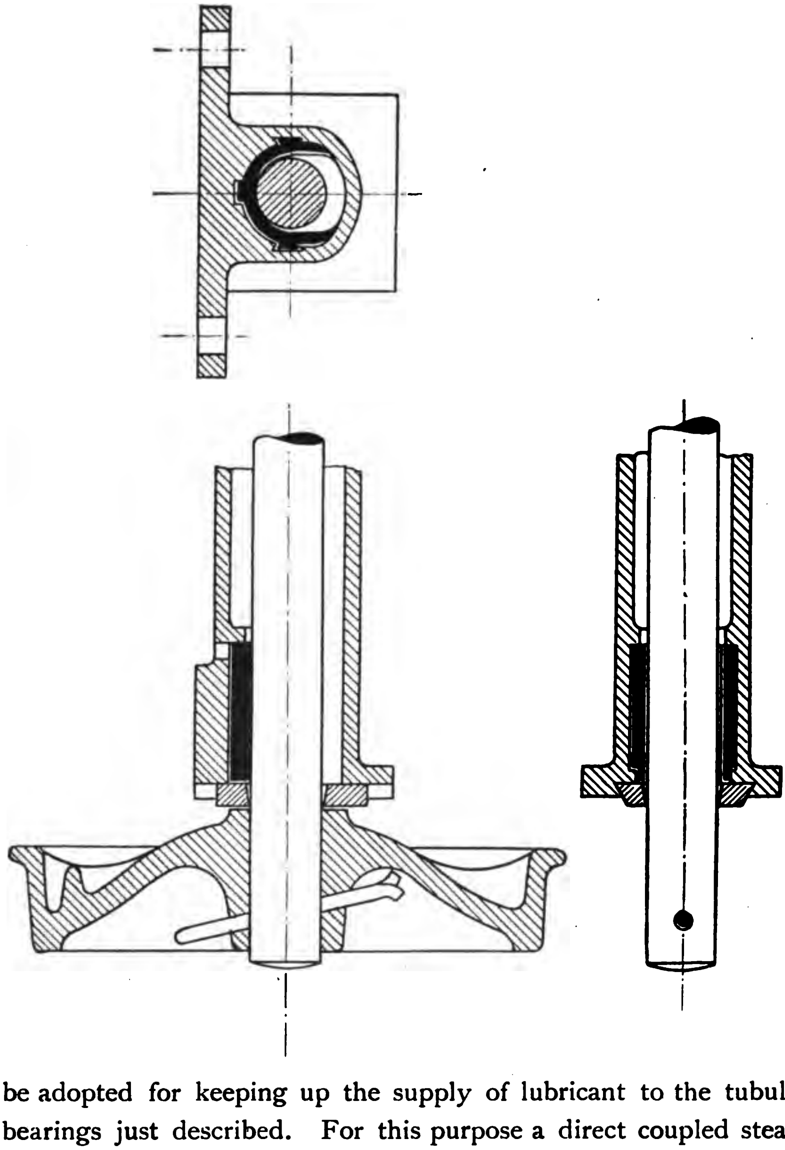


Fig. 16.

be adopted for keeping up the supply of lubricant to the tubular bearings just described. For this purpose a direct coupled steam engine (or compressed air motor) and oil pump can be recommended, the latter drawing the oil from a warmed storage vessel, and forcing

it through a pipe and suitable connections into the tubular bearing of the tub, which has been turned upside down in a tippler.

Though the weight of the tubular bearing is considerable, it at the same time greatly adds to the rigidity of the tubs, and renders any additional frame unnecessary. It has, however, in common with all bearings for solid lubricants, the defects of high friction and rapid wear. Loose wheels with oil lubricators would be preferable, were it not that existing forms are mostly unsuitable for pit work, journals that have worn loose, and therefore jolty, being a frequent cause of tubs leaving the track. At the same time it should not be

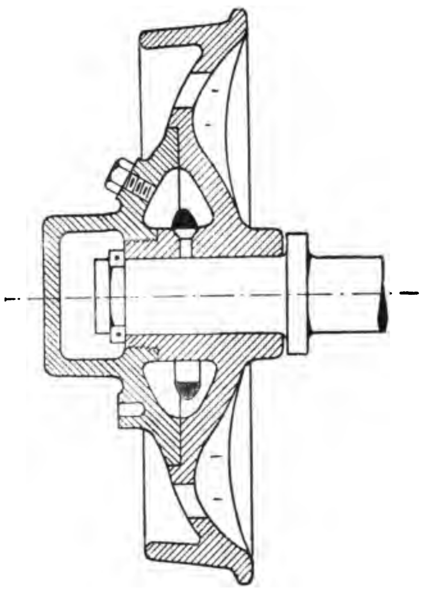


FIG. 17.

forgotten that—especially in coal mining—diminished friction and the resulting economy of motive power are not such very important items, and that a delay of several hours, on account of interruption of the haulage work, will nullify all the advantages that an improvement may possess. Fig. 17 represents the Schulz patent loose wheel.

Body and Frame of Tub.—The external shape should be such as to enable the sectional area of the haulage road to be properly utilised. Where wood is cheap this material is still largely used,

especially for large tubs; it is also better able to stand shock. The sides should be 1-2 ins. thick, the bed $1\frac{1}{2}$-3 ins. Angle iron fittings increase the rigidity and strengthen the corners; or the planks may be covered with zinc. Iron tubs are often provided with two longitudinal beams of wood in the frame, and a few transverse struts, which increase the elasticity and power of withstanding shock, but reduce the carrying capacity. The long timbers may

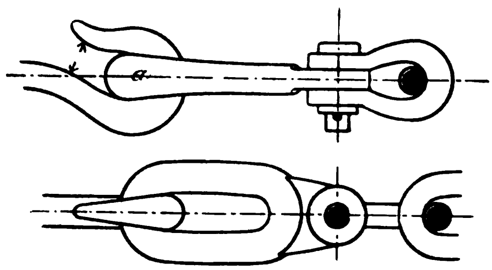


FIG. 18.

project and be faced with metal to serve as buffers. The shape of the body should be such that the horizontal projection conceals the wheels, and protects these susceptible parts against accidental falls of stone. The sheet-iron used is $\frac{1}{8}$-$\frac{1}{4}$ in. thick.

Coupling Tubs.—Hooks and links should be provided for this purpose, and arranged in a proper manner. When, in train haulage, it is not desired to transmit the whole force of traction to the tub

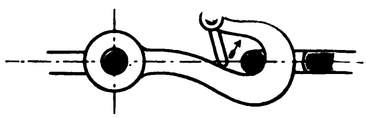


FIG. 19.

beds, a bar passing from front to back is attached to the bed or frame, the coupling hooks and links being fastened to the two ends.

Safety hooks are generally used, a small bow or ring being passed through the end of the hook; on hooking into the link, this ring gives way, in the direction indicated by the arrow, and afterwards drops down, thus preventing the coupling coming undone. Or the end of the link, *a*, may be thicker than the opening in the hook, so that the link must be turned through an angle of 90° before it can be slipped in (Figs. 18 and 19).

Brakes.—If the force producing a downward movement (relative gravitation minus friction) is represented by Z, then, assuming K to be the normal pressure that has to be applied to the wheel in order to check the movement, $K = Z$. Nevertheless, to ensure the tub being brought rapidly to a standstill, in the event of accidents, it is necessary to increase this brake power four to five fold. The pressure applicable by means of hand brakes may be set down as 45-70 lb., and that with the foot brake as 90-130 lb., the lower values referring to youths. The brake should automatically move away from the rim of the wheel when released. A few simple forms of brake for tubs are shown in Fig. 20.

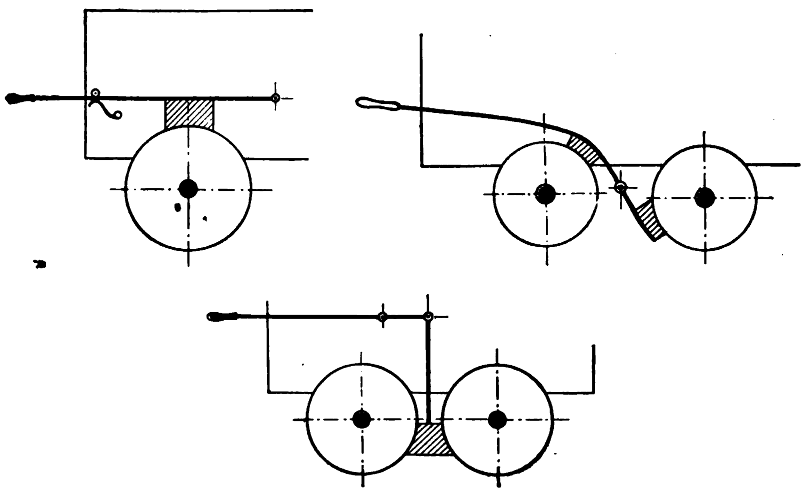


FIG. 20.

Flat Trucks for Inclines (Fig. 21).—Where the gradient exceeds 20° ordinary tubs will topple over, or else must be sent off only part full. In such event flat trucks are used to carry the full tubs, the latter being mostly pushed on from the side. When, however, the two haulage roads run in the same direction as the incline, arrangements must be made to push the tub off the truck without catching against the rope. With this object the rope, instead of being attached direct to the truck frame, fastens on to a strong iron bow, of sufficient height and width to allow the tub to pass through. If, by reason of heavy rock pressure, etc., it is necessary to reduce

the width of the incline as far as possible, the flat truck must be provided with a turn-table, so that the tub can be turned round at an angle of 90°, its greater diameter coinciding with the direction of the incline. The track gauge is 40-42 ins., and the wheels are small, to reduce the height of the truck, the defect of greater friction being of minor importance. The trucks must be strong, and more particularly well stayed and fitted with buffers, to take up the impact on the stops at the bottom of the slope. The tubs are held

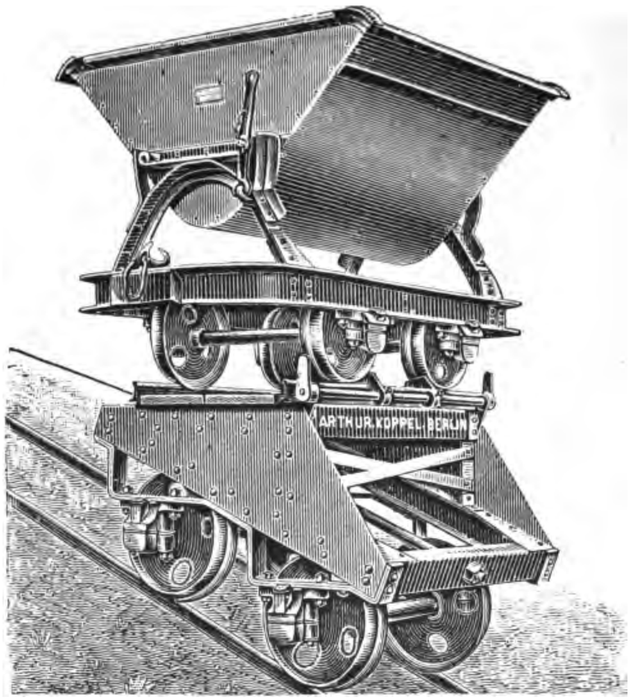


FIG. 21.

n position on these trucks in the same manner as in the cage (*q.v.*). Safety clutches are sometimes adopted, such as a hook, which, under ordinary circumstances, is held up by the haulage rope, but in the event of the latter breaking, falls down and bites in the floor. These appliances, however, are unreliable, and clutches like those used in cages would be better, but would entail the provision of expensive guides of strong timber, which in turn would hinder the provision of carrying rollers for the rope. Safety appliances placed

in the inclines themselves, and not attached to the tubs or trucks, are dealt with under " Inclines ".

Emptying Tubs.—This may be effected :—

1. By tipping the entire tub or the body only. Fig. 22 shows a tub arranged to tip forwards, the front wall being sloped ; Fig. 21 a trough or hopper-shaped tub, for tipping sideways. These are suitable for work above-ground—traffic between the preparatory works and the loading ramp, etc. The locking devices should be attached in such a manner as to preclude the possibility of the tub tipping over on the side at which the attendant stands when releasing the catch.

Fig. 23 represents the Nietsch tipping catch.

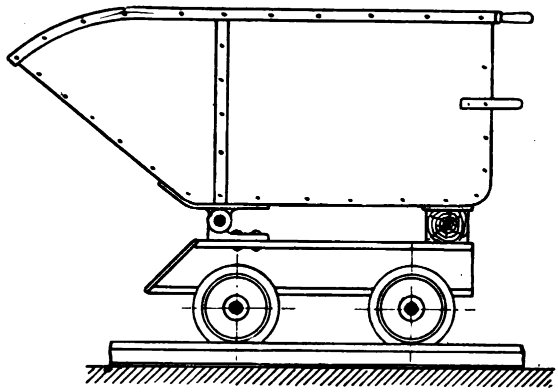


FIG. 22.

2. By providing doors in the sides or bed of the tub. These doors, however, are a frequent source of repairs, and considerably impair the rigidity of the tub body ; they must be hung in such a manner that they can swing freely when opened, otherwise they are liable to be knocked about and soon spoiled.

3. By overturning the entire tub on a tippler. This method ensures rapid and convenient discharge of the contents ; and when properly constructed, all injurious shock to the tubs is prevented, as well as damage to the coal. Fig. 24 represents a forward tippler (for pit heapsteads), mounted on a convenient portable and adjustable frame. Fig. 25 is a simple arrangement used in England, the axis of which is so disposed that the centre of gravity of the

empty frame is in front, and the common centre of gravity of the frame and the full tub in front of the axis of rotation ; hence the whole tips over as soon as the tub is pushed on. The common

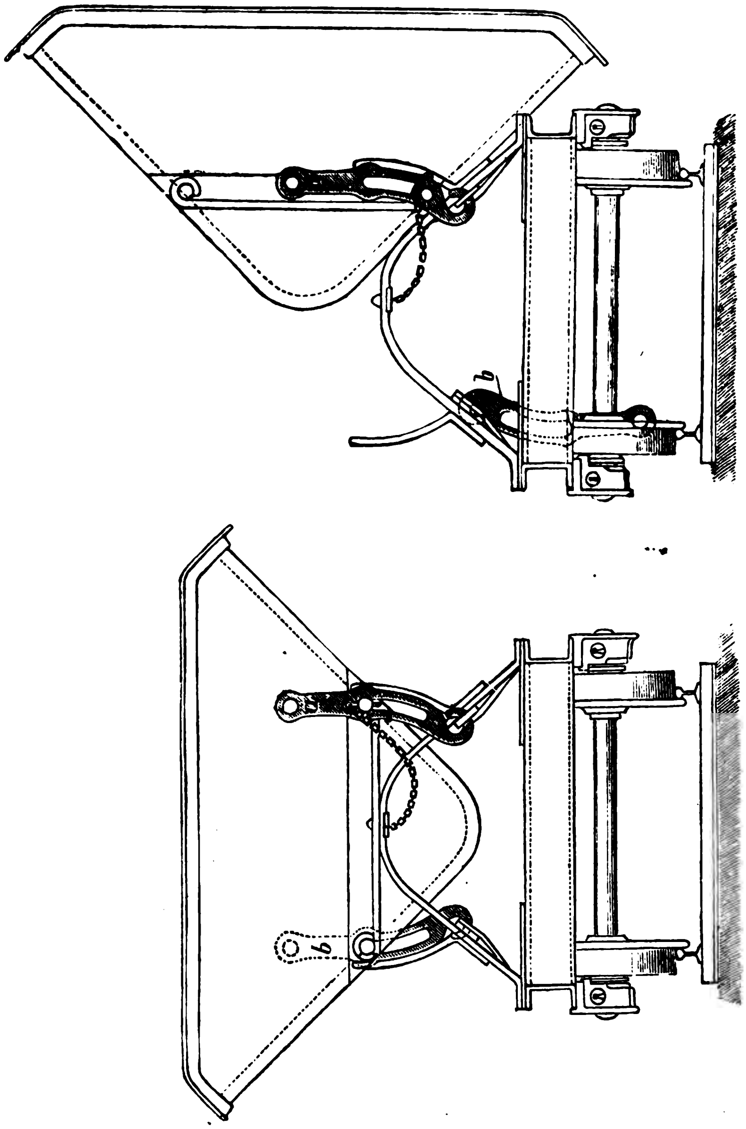


FIG. 23.

centre of gravity of the frame and empty tub being in front of the axis, the tippler returns automatically to first position. The angle of rotation is mostly 150°, and a stop is provided to limit the

travel. A better form is the circular or lateral tippler (Figs. 26 and 27), the depth of the shoot being smaller and the coal better protected from damage. For some loading purposes travelling tipplers

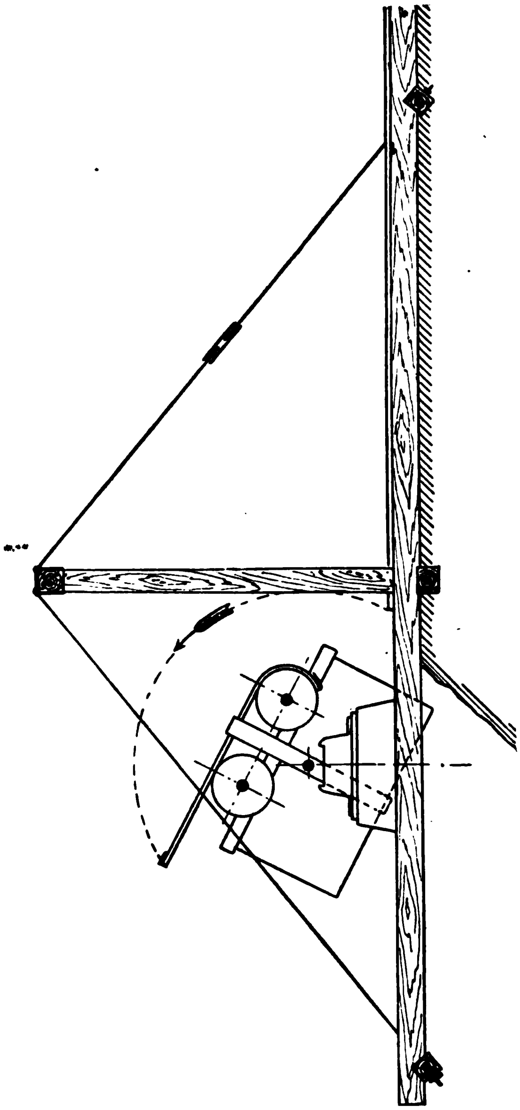


FIG. 24.

are desirable, all that is then necessary being to mount the carrier rollers on a U-iron frame running on wheels. In many instances the tipplers are worked from a driving shaft, from which motion is

transmitted to the carrier rollers by fast and loose pulleys or a friction coupling; or the tippler is fitted with a toothed rim. The movement can be regulated so that a uniform speed is maintained

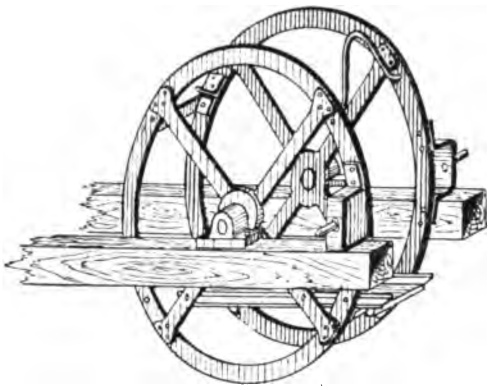


FIG. 25.

throughout, or the tub may be emptied slowly and then raised rapidly. This effect may be obtained by means of suitable driving gear, or more simply as shown in Fig. 28, where the roller, 1, works

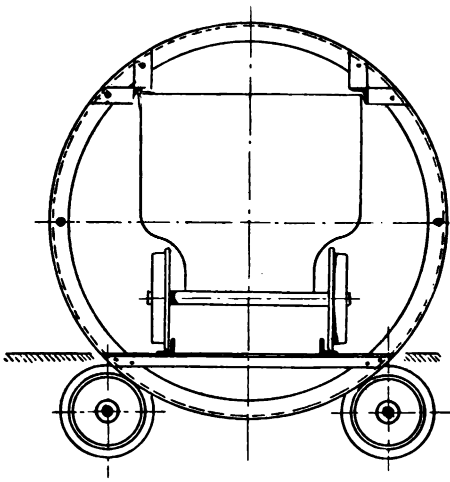


FIG. 26.

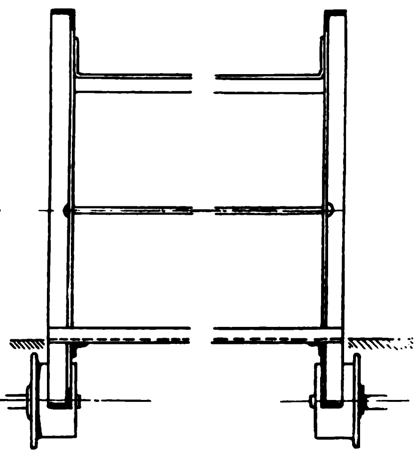


FIG. 27.

against the rim, *a*, whilst the rim, *b*, is thickened round part of its circumference by a bar, which, coming in contact with the roller 2, lifts away from 1 and leaves the tippler moving at a lower rate of speed, driven by 2. To ensure better contact the rollers and rims

are often fluted like friction gear. When the empty tub has been raised, the tippler is stopped by displacing the belt, throwing the

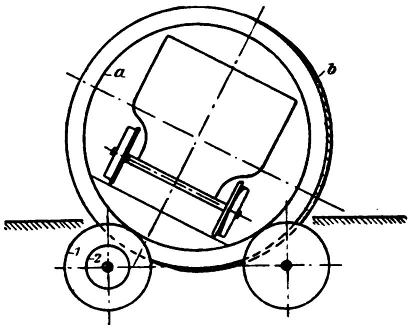


FIG. 28.

clutch out of gear automatically, or by recessing the rims at suitable places, so that the rollers cease to act on them.

CHAPTER III.

CAGES AND WINDING APPLIANCES.

CAGES.

THE cage consists of a top portion and several stages or decks, connected together by a strong framework. The rope is attached to the head, and the decks are loaded, at the pit eye, with the full tubs, which are removed when the cage has ascended to bank. The provision of several decks in one cage enables four, six or even ten tubs to be raised at one journey; moreover, these high, and comparatively narrow, multiple-deck cages adapt themselves better to the guides. On the other hand they take longer to load and unload, or necessitate the installation of special appliances—that cannot always be arranged as simply as is desirable—at the pit eyes and bank (see p. 44).

The head, decks and frame of the cage should be of bar and shaped iron, as light as possible, but well stayed. The side walls—especially of cages with several decks—are subjected to a strain, not merely of tension, but also of compression (or buckling) when lowered, and are also exposed to numerous shocks, on which account profile iron is preferable to plain bars for these parts. It is likewise better to allow the stops of the catches at the pit eye to engage below the upper framework of the cage, so that the latter is held by suspension and not supported from underneath. The flooring of the intermediate decks is often removable, and can be taken out when a compartment of greater vertical dimensions is required, *e.g.*, for conveying timbers, horses, etc. When the cage is used for conveying miners, the sides must be covered in with sheet metal or fine lattice work, and the ends fitted with doors of sufficient height and fastened from the outside. A loose sloping cover, cap-

able of turning back, must also be fitted to the cage, to keep out falling water or anything else that may accidentally fall down the shaft.

The dimensions of the cage are as follows: Height inside, 6 ft. if the men stand up, or 4 ft. at least if they sit down. Floor space per man, in the former event, 2 sq. ft., in the latter, $3\frac{1}{2}$ sq. ft.; weight of cage, 40-90 per cent. of the load to be raised.

The tubs are fixed in the cage (1) by bows, hooks or bars, resting against the tub sides, or (2) by pivoted bars inserted between the axles or in front of the wheel rims. For greater safety it is advisable to use both kinds together, or automatic locking devices which are released on the cage coming into contact with the stops at the pit eye or bank.

Shaft Guides.—The proper guiding of the cage is a very important point, and is secured by means of rods, extending the whole length of the shaft, and attached to horizontal beams.

The guides rest against the sides or ends of the cage, the arrangement mainly depending on the dimensions and partitioning of the shaft. End guides require a smaller amount of timber, take up less room, and on account of the greater distance between the points of contact, prevent the swaying of the cage more effectually than if arranged at the sides. At the same time they prevent the tubs falling out and damaging the shaft in the event of any breakage of the closing device of the cage. On the other hand, the main guides must be cut away, and replaced by lateral guides, at the pit eye and bank, in order to enable the tubs to be run in and out of the cage. However, this is unnecessary when each deck of the cage accommodates two tubs, side by side, since then the tubs can be run past the guides on either side. Iron rails or profile bars are for the most part arranged on one side of the cage only, a single set of superposed cross bars, between the cage compartments, then sufficing to carry the guides. When wire cables are used for guiding cages, three or four points of attachment are employed.

Timber Guides.—Oak or pine timber, free from knots, or American woods are used. Dimensions, 4 × 6 to 6 × 8 ins., the broad side being mounted on the cross beams (timber, **H**- or **U**-

irons) so as to fit accurately and run exactly vertical. Attention must be bestowed on arranging the guides and supports so that they are readily accessible and removable.

The guide timbers are fitted together as in Fig. 29, or by means of wrought-iron fish-plates, the joints resting on the cross timbers.

Contact between the cage and the guides is effected by means of cast-steel slides or wrought-iron lugs screwed on to the head

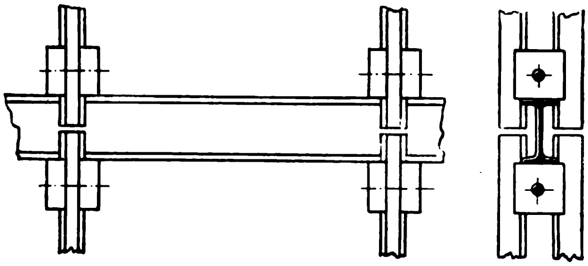


FIG. 30.

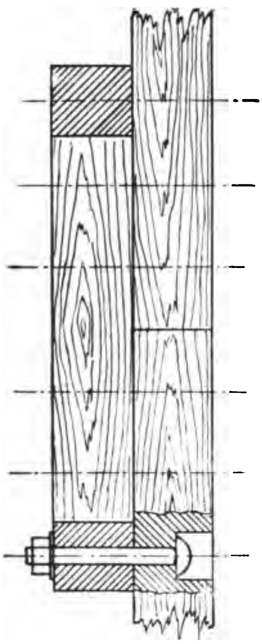


FIG. 29.

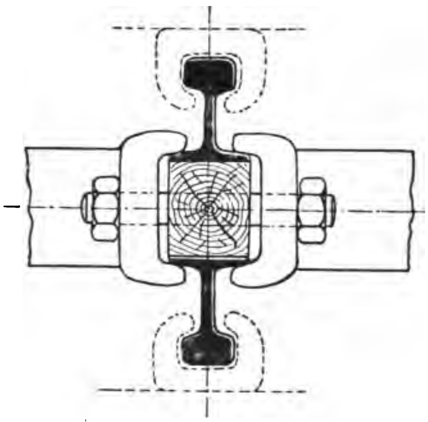


FIG. 31.

and floor of the cage, and engaging with the guides on three faces, with a play of $\frac{1}{4}$-$\frac{1}{2}$ in. Sometimes these short shoes are replaced by bars extending the full height of the cage. Both ends of the shoes are widened and rounded off.

Owing to the comparatively short life of wooden guides, and the disturbance to mining operations entailed by their frequent renewal, they are gradually being replaced by iron guides, which also enable the play between the guides and slides to be reduced,

thus improving the guiding and allowing a higher speed to be safely attained in winding. On the other hand, they retard the action of the safety clutch. Figs. 30 and 31 represent the Briart guides, made of iron rails; but **U**- or **T**-irons can also be used.

Wire Rope Guides are very popular, for medium depths, in English pits. The guide ropes—closed rope or cable constructed of a few thick wires ($\frac{2}{5}$-$\frac{3}{5}$ of an inch in diameter)—are anchored firmly above-ground, and hang free in the shaft, down to the very bottom, where they are passed through a frame built into the shaft walls, and are strained taut by means of heavy weights. The cages, however, sway considerably, so that a free space of 12-16 ins. must be left on either side; and hence, although cross timbers are dispensed with, these guides require wide shafts. The eyes traversed by the ropes are usually of hard bronze, and the cages are guided at three or four points. Sometimes the ropes between the cages are not used for guiding, but merely to prevent their coming in contact with each other.

Guides of iron or wire rope must always be kept well greased.

Safety Catches.—These are designed to prevent the cage falling down the shaft in the event of a breakage of the winding rope. These accidents may be caused by defects in the rope or connections, overwinding, sticking or jamming of the cage—in which event, on the down journey, the rope may hang in loose coils above the cage, so that the latter, when released, falls suddenly and breaks the rope. Other causes are: fractures of the guides, head pulleys, etc. The fundamental principle of safety catches can be gathered from a description of the appliance of White & Grant, illustrated in Fig. 32. When the rope is taut, the spring, *f*, is held in tension, and the toothed catches, F, are in the position shown, *i.e.*, about $\frac{5}{8}$ of an inch from the guides. When the rope breaks, the spring, *f*, is released, and then presses the pivoted catches, F, so tightly against the guide beams that the teeth bite into the wood, the weight of the cage pulling them further in. As the spring is also released when the cage is held by the keps at the pit eye, the weight being then off the rope, corresponding recesses are cut in the guides; and the condition of the catch can always be ascertained by watching

how the eccentrics, F, play when in this position. Swayings of the rope, and the pressure of acceleration under increasing velocity in winding, often reduce the rope tension on the descending cage. To prevent the catch coming into action under these circumstances, only about $\frac{7}{10}$ of the weight of the empty cage is applied to keeping the spring, *f*, in tension; and this proportion can be suitably modified by using several springs, or a train of levers between the spring and the rope. The residual weight of the cage and load is taken up by a connection, A, of the king rod, or by stirrup chains.

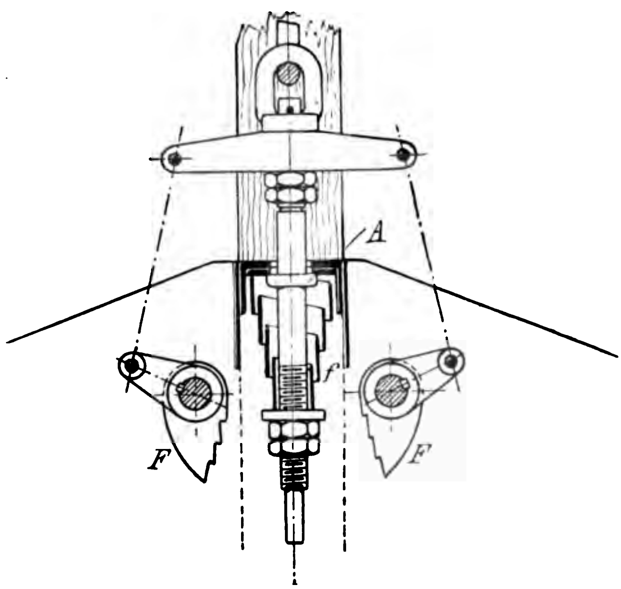


FIG. 32.

Von Hauer divides the safety catch into three parts :—

1. The catches (F, in Fig. 32);

2. The motor (the spring, *f*, in Fig. 32);

3. The intermediate gear, conveying motion between the motor and the catch.

The stopping of the cage should ensue as quickly as possible, before it has had time to attain any high velocity in falling, and before the effectiveness of the appliances has been impaired by the slinging and looping of the rope tail. The principal conditions favouring the rapid action of the catches are: short length of stroke

of the catch from the position of repose to the point of contact with the guides, and a relatively short travel of the rope end (stirrup, king rod) against the cage. The spring tension should be as high as possible, the play of the spring necessary to bring the catch into action small, and the difference between the spring tension for raised and depressed catch slight.

Latterly these quick-acting catches have been progressively abandoned in favour of fall brakes, which act without shock, the kinetic energy of the descending cage being gradually consumed during a long brake stroke. The resistance checking the cage

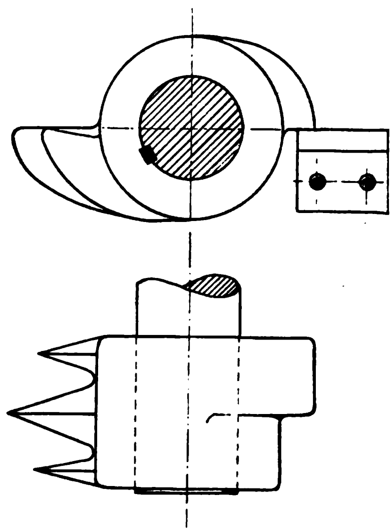


FIG. 33.

when the catch comes into play must increase from zero to a figure equal to two or four fold the weight of the cage at least; but, on the other hand, must not be of such magnitude that the check is too suddenly applied. The old White & Grant safety catch has been altered into a fall brake, in a very ingenious manner, by Oberegger, for example. The catch (Fig. 33) consists of three knife edges, which, when pressed against the guides, cut furrows in the wood. The depth to which they can penetrate is limited by a stop, which forms a measure of the maximum braking resistance, the latter being also capable of apportionment according to the weight of the cage, by adjusting the angles of the cutters.

Externally similar to the old eccentric catch is also the new brake-action safety catch of Gerlach & Boemke (Fig. 33*a*). In the event of the rope breaking, a spring turns the catch shaft, W, in the direction of the arrow, and presses the toothed rings, R (which are mounted loose on the eccentric disc, S), against the guide. The rings revolve and set up strong friction against S ; and the pressure between R and the guides increases, by the nearer approach of the eccentrics, until the *vis viva* of the cage is consumed.

By altering the angle at which the eccentrics are set, the braking action can be accelerated or retarded, or the catch can be utilised for greater or smaller loads.

The Muenzner Safety Catch (Fig. 34, Plate I.) is also largely used. As can be seen from the sketch, Fig. 34*a*, the blades A, B are turned in the direction C, D for action, thus forcing their way into the guides and cutting furrows in the wood. The pivots of the blades are connected by a cross-piece, which is pressed downwards in the event of the rope breaking. This catch also merits special attention as having been employed, in conjunction with the Undeutsch apparatus, for the determination of very precise measurements respecting the distance traversed between the time of the rope breaking and the catch coming into action, and also of the injurious effect of the breaking of the rope, and the subsequent check, on occupants of the cage. If, in addition, the resistance opposed to the blades by the wood be determined by experiment, then all the materials for calculation will be at hand.

The Hoppe Catch (Fig. 35).—This is used in the case of guides of T-iron, the spring released on the breaking of the rope raising the two brake cheeks until they press firmly on the surface of the iron guides. The resulting friction causes the brake cheeks to lag behind the cage, the eccentric elbow-levers, K, assume a more and more horizontal position, and the pressure increases until the further movement of the cheeks is prevented by striking against a stop on the cage frame. From this point onwards the pressure and friction between the brake cheeks and the guide remain unaltered, the *vis viva* of the cage is gradually consumed and the latter brought to

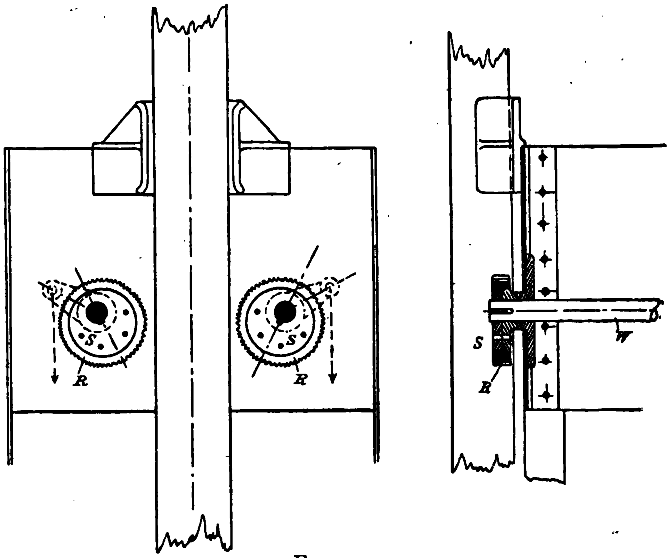


FIG. 33a.

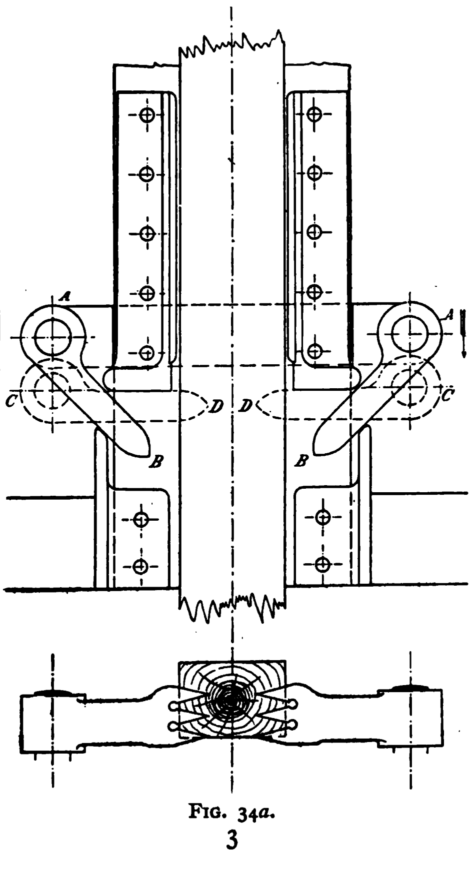


FIG. 34a.

a standstill. The distance traversed in the interval is often 5 ft. and over. The pressure on the levers, K, tends to force the abutments, W, outwards, and if these are bolted firmly on to the framework, there ensue in the latter elastic changes of form which determine the extent of the maximum pressure exerted by the brake cheeks. This pressure, however, will be immediately reduced in a considerable degree as soon as the guides are worn down a small fraction of an inch, and consequently the outward thrust of

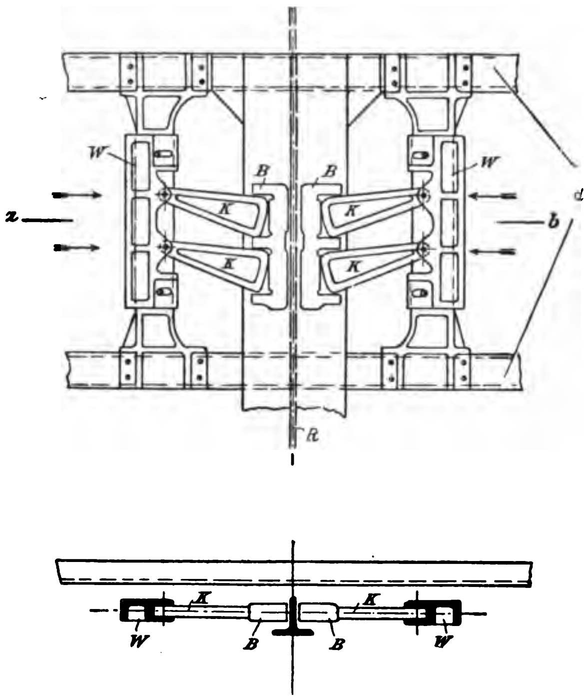


FIG. 35.

the abutments is correspondingly reduced. For this reason the abutments, in the later models, are mounted so as to slide in the direction *a*, *b* instead of being bolted fast. By the intermediary of elbow-levers, the pressure of very powerful springs is transmitted, in the direction of the arrow, to the abutments, the flexion of these springs thus fulfilling the same purpose as that of the framework in the older pattern, with this difference, however, that the brakes still act in a reliable manner even when the guides

are considerably worn. At the same time no troublesome adjustment is necessary, neither does the brake act too forcibly and suddenly in the case of new guides.

In the case of Briart guides, the Hypersiel catch is often used, in which, on the rope breaking, a fork, fluted on the inside and tapering downward, grips against the guide bars (Fig. 35*a*).

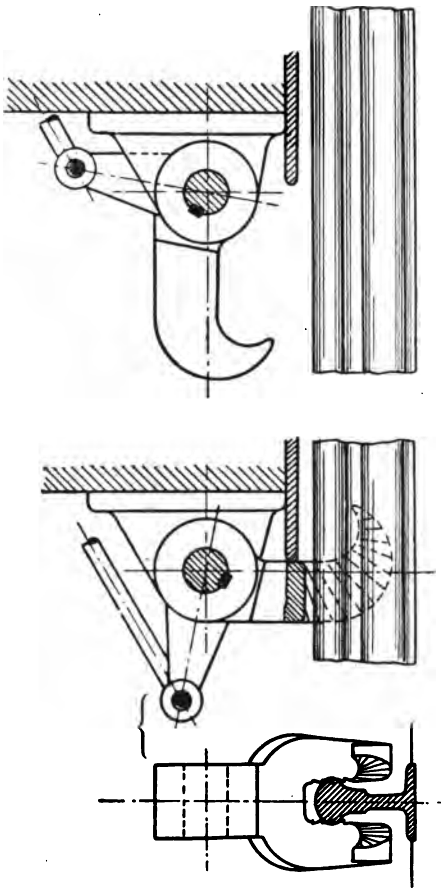


Fig. 35*a*.

Connection between Cage and Rope Cap.—In Fig. 32 the cage is shown suspended by a bridle chain attached to the rope cap, a swivel and an adjusting screw being often interposed between them, as shown in Fig. 36, the former appliance serving to correct the twist of new ropes, and the latter for accurately regulating the

length of the rope. In the event of the bridle chains breaking, the load is taken up by safety chains between the rope cap and the upper frame of the cage. The bridle chain is made of best wrought-iron, and must be examined daily, and also be carefully annealed from time to time. At the same time the bridle chain prevents the looping of the over-long rope when the cage is on the keps, and

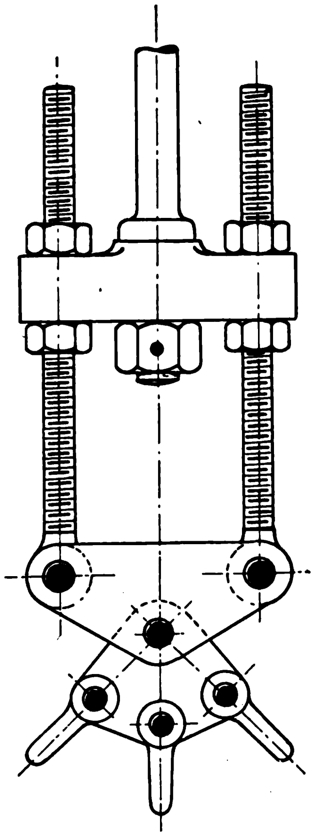


FIG. 36.

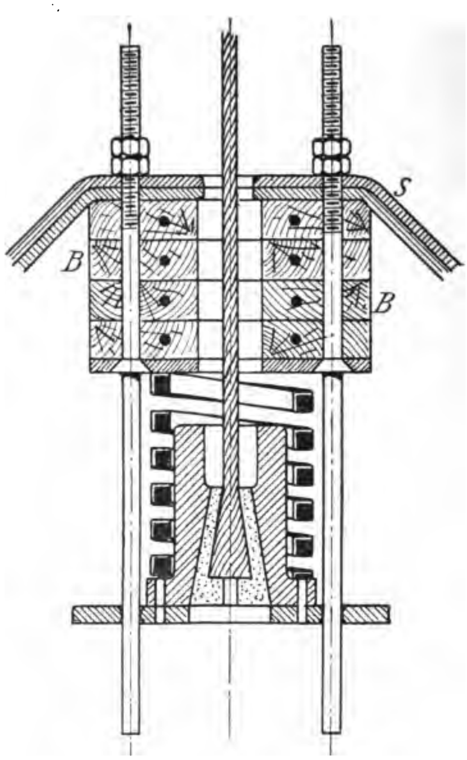


FIG. 37.

thus protects the wires from breaking above the cap. However, in improved forms of winding drum, the length of rope can be so accurately adjusted that it is possible to dispense with the dangerous bridle chain.

Fig. 37 shows a method of connecting the cage and rope, in which hanging of the rope is prevented by a spring and guide

blocks, BB, whilst ensuring at the same time an elastic starting pull.

On the other hand, such springs retard the action of the safety catch. Means must also be taken to prevent the rope becoming detached from the cage in the event of the spring breaking.

Every shaft should have at least five cages: two in use, an equal number in reserve, and one under repair. The reserve cages should be kept on low trucks, to facilitate changing as quickly as possible.

KEPS.

It is essential that, both at bank and at the pit eye, the cage should rest exactly on a level with the tracks on which the tubs are conveyed; and to retain the cage in that position the appliances known as keps are provided.

The simplest form of keps is shown in Fig. 38, and consists of pivoted stops, *a*, mounted loose on a shaft and abutting on the nose-pieces, *c*. Two levers are keyed on this shaft, a long one, *h*, and a short one, *b*, carrying studs engaging below the stops. The ascending cage which lifts the loose stops must be drawn up far enough above its position of repose for the stops to fall back underneath it into their original position, whereupon the cage is lowered again on to the keps. When the exchange of tubs is completed and the cage is to be lowered again, it must first be lifted far enough to allow the stops to be turned back by means of the lever, so as to leave the shaft free for the cage to descend. At the pit eye the cage rests on the projecting stops, direct. Of course when coal is wound from haulage roads at different levels in the shaft, great care must be taken to prevent any of the intermediate keps being allowed to project, either by accident or of *malice prepense*. Lockable keps, or signals indicating to the engine driver which keps are set, are in use.

When work is very brisk, the time consumed in raising the cage above the keps, lowering it, and then raising it again, becomes inconvenient, and consequently keps have been introduced that allow the cage to descend without the preliminary lift. Most of these appliances are based on the action of elbow-levers. Out of the

numerous existing types —constructed by Frantz, Ochwadt, Westermeyer, Stauss, Albert and others—mention may here be made of the "Asphaleia" keps (Fig. 39). A shaft, *d*, is mounted in two slides, *b*, capable of moving back and forth in slots cut in the frame,

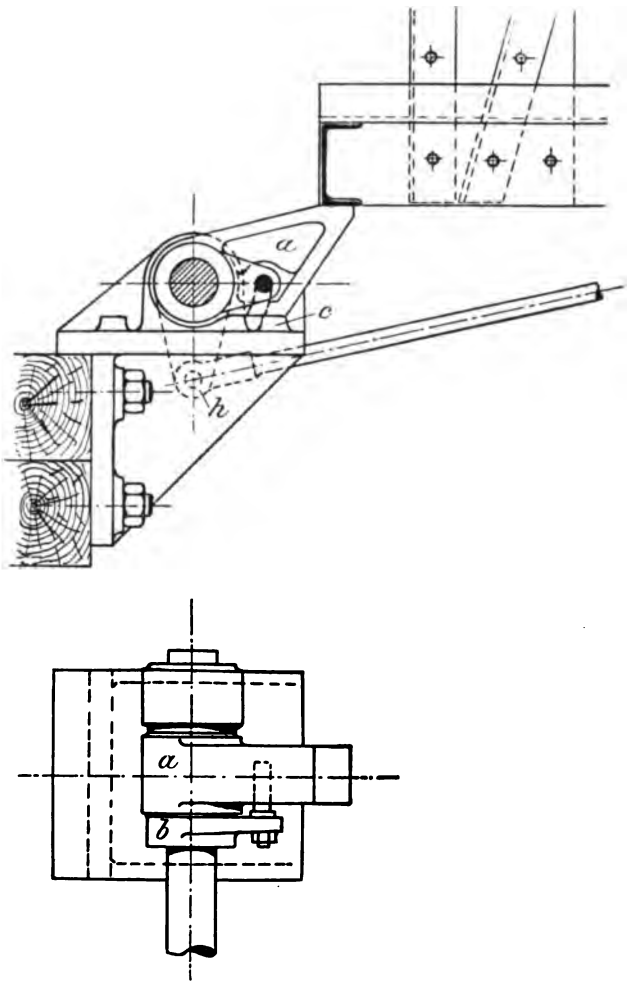


FIG. 38.

a. The shaft, *d*, carries the loose stops, *e*, and the lever, *k*, which forms a double joint with the lever, *h*, keyed on the hand-lever shaft, *g*, which joint is slightly depressed when in the position of repose. Counter-stops, *o*, are fixed on the under frame of the cage. Setting-on is effected the same way as before, the cage being lifted

a few inches above the level of the bank. To allow the cage to descend the lever is pulled and draws back the stops, the cage

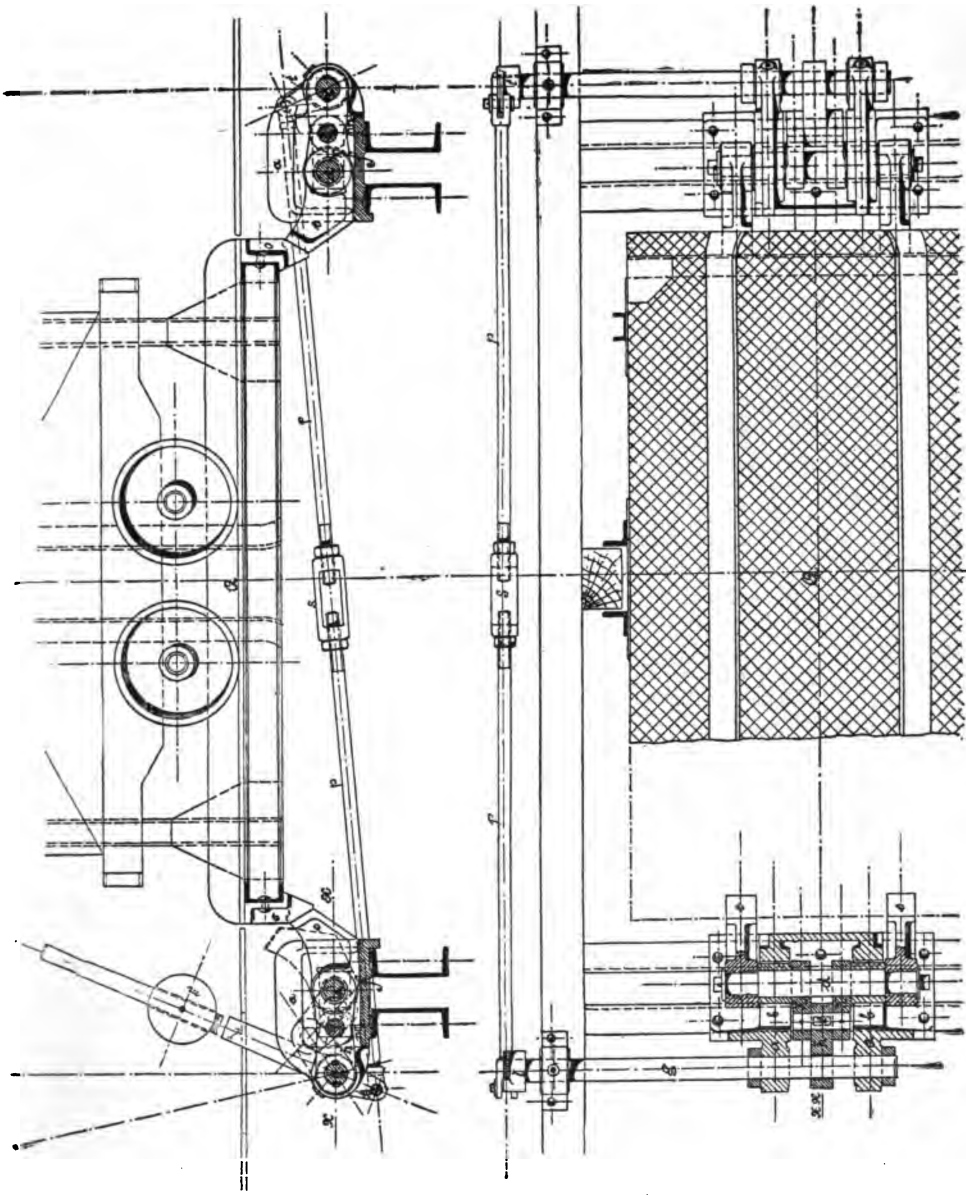


FIG. 39.

sliding quietly over the sloping surface thus presented, and consequently there is no jolting, even if the rope hangs somewhat loose.

Fig. 40 represents the Haniel & Lueg keps, when the cage is set on, and also when the latter is descending and rising, respectively. The bearing frame, *g*, and the lever, *k*, keyed on the shaft, *f*,

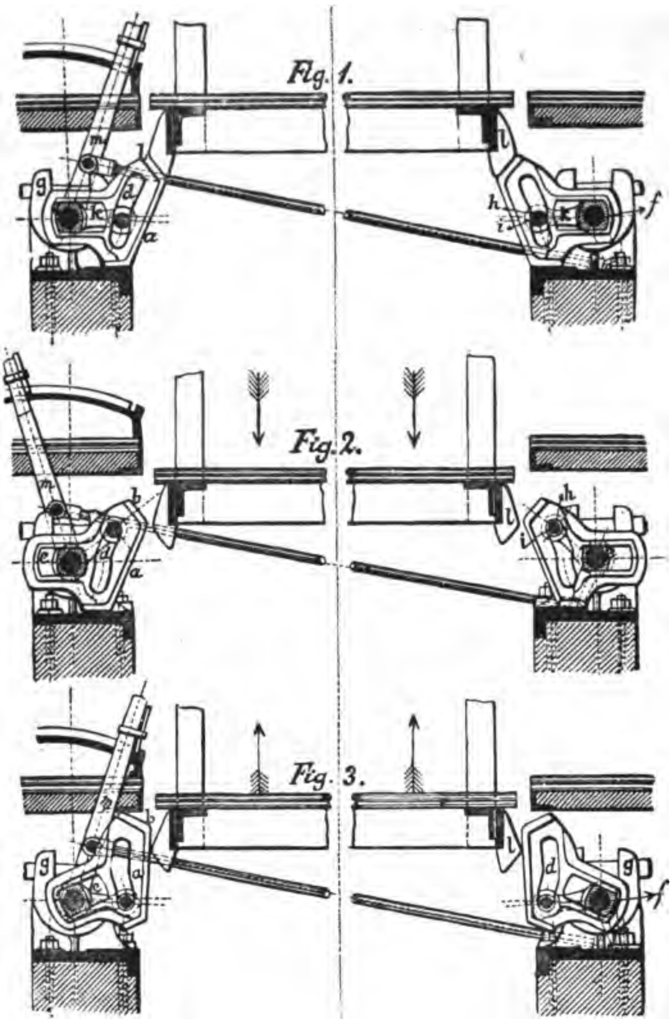


Fig. 40.

are in duplicate, one on either side of the stop, *a*. When the hand-lever is moved, and *k* with it, the pin of the stop is drawn backwards in the slot, *d*, and thereby slides on the base-plate and on the block seen in cross-section. This latter is loosely mounted on the

shaft, *f*, so that the ascending cage is enabled to move the stop and the block upwards in the manner shown.

To reduce the shock in setting-on the cage, it is preferable to mount the keps on somewhat elastic iron or wooden girders.

Shaft-closing Devices.—The opening of the shaft is enclosed by railings, provided with doors or collapsible lattices, which are closed except when the cage is in position for the change of tubs. As a rule these shaft doors are locked by bars which are pushed away by the cage, and when the shutter-gates are collapsible in a vertical direction, they are fitted with arms, which project into the

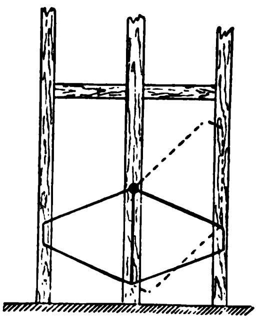


FIG. 41.

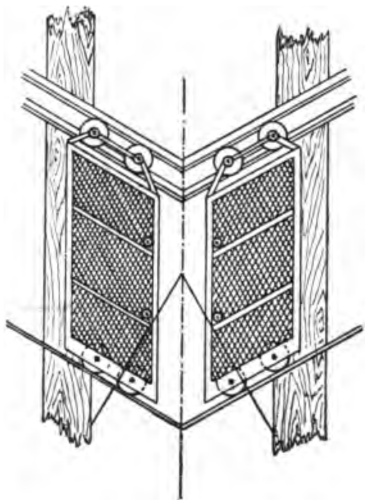


FIG. 42.

shaft and are lifted by stops on the rising cage. To prevent concussion, the lattices are made as light as possible and counterpoised, and the cage stops are fitted with buffers. The task of lifting the lattice can also be performed from the winding drum shaft, a wire rope attached to the gate being passed over pulleys to the engine room and there wound on a small drum, which is set in motion by the engine just before the cage reaches the bank. The coupling up of this drum at the proper moment may be effected by a collar moving along a revolving screw spindle.

Doors are also provided at the pit eye, chiefly for the purpose of preventing the tubs being run into the wrong winding compartment

of the shaft. A simple form of these doors is shown in Fig. 41, consisting of a light rhombic frame pivoted at the upper angle and turned by the oncoming cage in the direction shown by the dotted lines, thus closing the other compartment.

An automatic closing device, the Mauerhofer system, specially designed for intermediate floors in the case of hoists or blind shafts, is shown in Fig. 42. The opening into the shaft is closed by two sliding doors running on inclined rails. The cage is fitted at the top and bottom with a wedge-shaped attachment that makes contact with small rollers and pushes the doors outwards.

Closing Device for Ventilating Shafts.—If the winding shaft

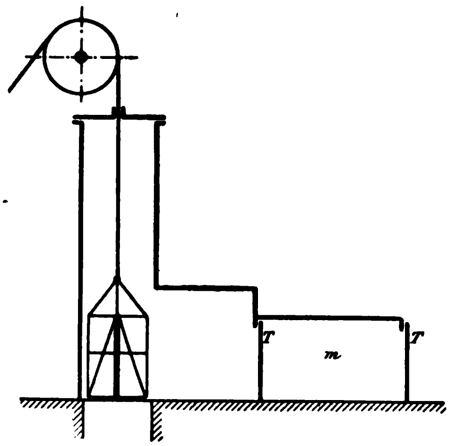


FIG. 43.

also serves for ventilation (as an upcast), it must be closed at the top. In Fig. 43 the pit mouth is enclosed in an air-tight tower of masonry or iron, the change of tubs being effected by the aid of two tight-fitting doors, T, and the chamber (air lock), *m*, without allowing the outside air to gain access to the shaft. A simpler method is to close each winding compartment with a cover, in the centre of which is an aperture for the passage of the rope. This aperture in turn is closed by a small cover which shares the unavoidable swayings of the rope. Below the mouth, the shaft is lined for a distance rather deeper than the height of the cage, and of such diameter as to leave but very little play at the bottom of the cage. By this arrangement the ascending cage first closes the

winding compartment and then pushes up the cover. The shock is ameliorated or prevented in the same way as with lattice doors.

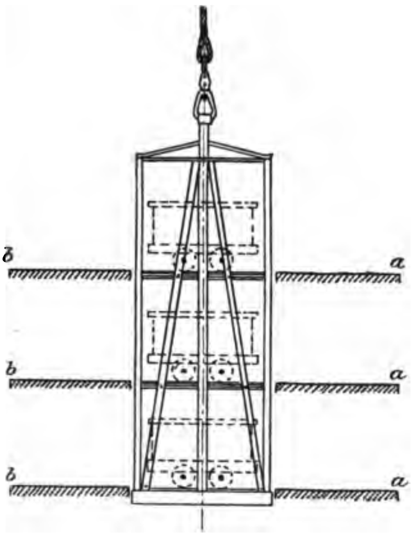


FIG. 44.

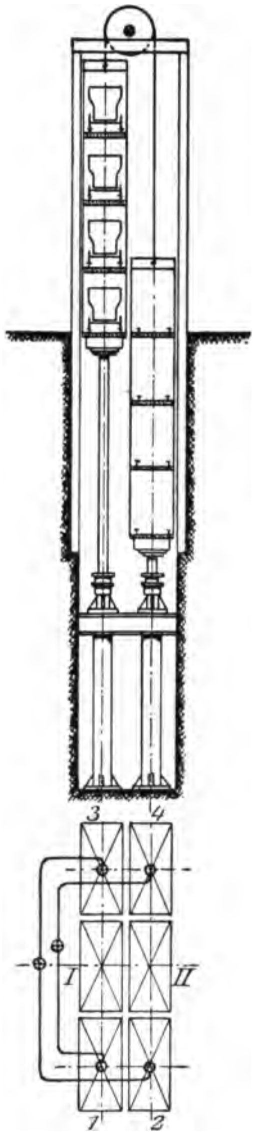


FIG. 45.

CHANGING TUBS IN MULTIPLE-DECK CAGES.

1. The several decks are successively brought to the level of the bank by raising or lowering the cage with the engine.

This method wastes time, entails great care on the part of the driver, and increases the consumption of steam. It is particularly unsuitable when conical drums or pulleys are used, wherein the rope coils are of unequal diameter, and consequently in raising or lowering one cage the other does not move to an equal extent.

2. The lowered cage is not adjusted by the engine, but rests on a platform that is lowered the height of a deck after the tubs have been changed. This facilitates the handling of the cage, especially in the case of conical winding drums.

1 and 2 cannot be recommended for cages with more than two decks.

3. Changing the tubs on all decks simultaneously. In this system, floors, *a*, *b* (Fig. 44), of the same height as the cage decks, are provided at bank and the pit eye. The tubs are pushed out of all the decks at once on to the floors, *a*, whilst those to replace them are kept ready on the floors, *b*. The cage then makes a trip up or down the shaft as the case may be, and in the interval the tubs on *a* are removed, whilst fresh ones are run on to *b*. This is effected by tracks running from the different floors to a common level (a plan that entails greater space than is conveniently available, at the pit eye especially), or else by the aid of small hoists, or movable hydraulic stages, the best method being to make the floors *a*, *b* movable, so that there are, as it were, supplementary cages on each side of the actual working cages.

Fig. 45 shows the arrangement devised by Tomson. The supplementary cages 1 and 2, 3 and 4, are connected by a chain, and also rest on hydraulic plungers, the cylinder of No. 1 being connected with that of No. 4, and the same applying to Nos. 2 and 3. Then, if the full tubs are loaded on to No. 1, their weight in descending raises No. 4, which is filled with empties on each deck as fast as No. 1 is discharged. On cage 2 coming to bank the full tubs are discharged into 2, which raises No. 3, and the empties from No. 4 take their place, and so on.

A regulator enables the rate of descent to be controlled and the cages to be stopped in any position, and also admits water to the hydraulic cylinders in the event of the weight of the full cage being insufficient to raise the corresponding empty one.

CHAPTER IV.

WINDING ENGINES FOR VERTICAL SHAFTS.

THIS work is performed by the aid of steam, compressed air, water power or electricity; more rarely by hand labour or animal power (winches, whims).

(*a*) STEAM ENGINES.

The general arrangement of a steam winding engine is shown in Fig. 46 (Plate II.). On the engine shaft are mounted two drums, from which the upper and under ropes run over guide pulleys to the shaft. The one rope, carrying the full cage, is drawn up, the other, with the empty cage, descends. Consequently, the ropes are alternately wound and unwound on the drums, which latter must therefore change their direction of movement every trip. On this account the engines have to be reversible, and generally also capable of overcoming different resistances, since not only may the load vary in each trip but also the pull exerted by the descending cage increases with the weight of rope paid out, whilst that of the ascending cage decreases. Hence the reversing and valve gear is the most important part in a winding engine, the other parts differing nothing in principle from ordinary engines.

Reversing Gear.

It is only in the case of small winches, or when locomotive engines are used, that the direction of movement of the winding drum can be changed without reversing the engine; for the most part the latter must be fitted with reversing gear.

1. **Slide Valve Gear.**—The reader is presumed to be acquainted with the nature of simple shell-valve gear.

The internal gear parts comprise ordinary shell valves, load-freed flat valves, separated slide valves, Allan trick valves, plunger valves and rotary valves.

However, as in locomotives, the simplest forms alone have made any headway. The *external* parts consist almost exclusively of eccentrics, link-motion and valve-rods. Only in the case of so-called "internal valve gear" (without expansion, suitable merely for small winches) is the link-motion dispensed with. Reversing by means of loose or sliding eccentrics has gone out of use.

(*a*) *Link-motion Gear.*—The Stephenson link-motion is shown in Fig. 47*a*. On the crank shaft are two eccentrics, E_1 and E_2, set at an angle of $90 + \delta$ with the crank. The eccentric-rods are attached to the ends of the sector, which is suspended by a pivot, *w*. The valve-rod, *s*, passes through a special guide, and is bolted on to a

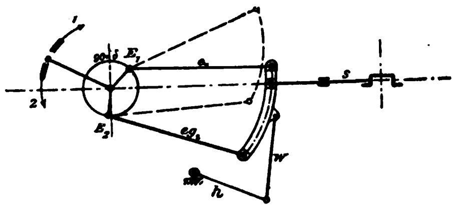


Fig. 47*a*.

sliding piece. When the link is in its lowest position, as shown in the Fig., the movement of the eccentric-rod, e_1, is transmitted to the valve, with practically no alteration, and the gear works as though only a single eccentric were present, set so as to lead the crank by an angle of $90 + \delta$. Motion occurs in the direction indicated by the arrow, 1. When the lever, *h*, is raised and the link consequently lifted into its highest position, then the motion of the eccentric-rod, e_2, is transmitted to the valve. At the same time, as can be seen from the Fig., the valve is reversed, and the engine begins to run in the direction of arrow 2, since the eccentric necessarily always leads the crank. When the link is in the central position, the steam pipe is closed, or at any rate opened to such a small extent that the engine does not continue to run.

It can be demonstrated that, in any position in which the travel of the valve is influenced by both eccentrics, the valve play is pre-

cisely the same as though there were only one eccentric present, but with a lead greater than δ and a diminished eccentricity, and therefore a valve with earlier cut-off. The momentary centre of such a hypothetical single eccentric, which, for any given position of the link, would give the same distribution of steam as the two actually present, is situated along the dotted curve E_1, E_2, Fig. 47*b*.

The shape of this curve causes an alteration in the so-called

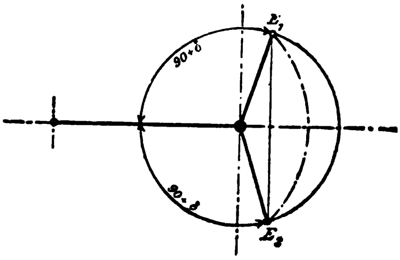


FIG. 47*b*.

"linear lead" (the opening of the admission valve when the crank is at a dead point), which is increased as the cut-off is accelerated. This defect is obviated by Gooch's device, wherein the centre of the supposed eccentric is displaced along the straight lines E_1, E_2. Fig. 48 shows that in this gear it is the sliding piece and not the link that is raised and lowered. The gear is longer than that of Stephenson, and is therefore unsuitable for necessarily compact

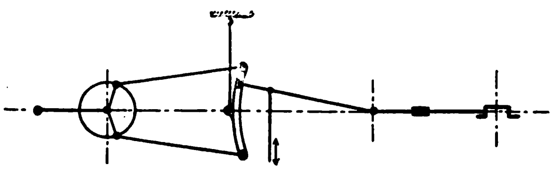


FIG. 48.

engines. The other classes of valve gear (those of Allan, Heusinger, Fink, Klug, etc.) are not much used; they are more suitable when, as in the case of locomotive or marine engines, it is desired to have a particularly favourable distribution of steam during the forward movement of the engine. Occasionally, separate admission and exhaust valves, each fitted with link-motion, have been constructed; but though these are accompanied by advantageous lead and

cushioning, together with high expansion, they are more difficult to look after.

Movement of the Reversing Lever.—It has been mentioned that the raising or lowering of the link also entails the shifting of the valve, and hence the friction of the valve has to be overcome. For this reason the reversing of large engines with flat valves necessitates a considerable exertion of force. Now, it is essential for rapid, and at the same time safe, winding, that the reversing-lever should be movable with ease and celerity; and, if only for this reason, preference is given to plunger or circular valves over flat ones.

The working of the lever can be facilitated by supplementary

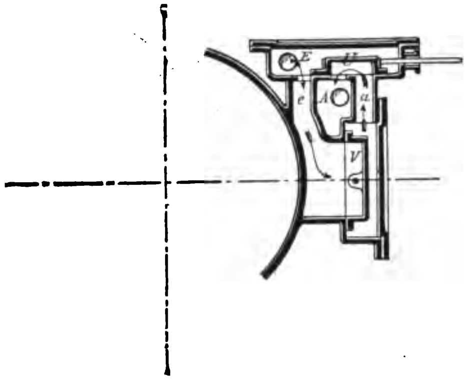


FIG. 49.

gearing, consisting of a small cylinder (for steam or hydraulic power), the piston of which actuates the reversing-lever, leaving only the valve of this supplementary engine to be worked by the driver. Naturally, this supplementary engine must enable the gear to be set to any desired cut-off, and consequently the cylinder diameter is usually made so small that the cylinder pressure is insufficient to move the link without the assistance of the machinist; or the piston-rod of the supplementary engine is prolonged rearwards and fitted with a second piston which works in a braking cylinder. The latter is filled, *e.g.*, with oil, and communication is established between the two ends, so that when the desired position of the link is attained, the closing of this means of communication prevents any further movement of the supplementary piston.

(*b*) *Internal Reversing Gear.*—This class of gear prevents any lap or lead, and therefore any expansion or cushioning. The steam consumption is high, and the efficiency is diminished by throttling, or applying a brake to the main shaft.

Internal reversing gear is divided into two kinds. In one, the engine is reversed by means of a special reversing slide or cock, which causes the admission valve to play the part of the exhaust, and *vice versâ;* in the other, the distributing valve is composed of two valves, one acting while the engine is running forwards, the other when it is reversed. A type of the first kind is illustrated in Fig. 49. When the reversing valve, U, occupies the position shown, the distributing valve, V, acts as admission valve, the steam entering from the inside, and the space above the valve is in communication with the exhaust, A. On turning U towards the left, the steam enters through *a* and escapes through *e*. It is necessary to provide some means of preventing the valve being raised from its seat by the steam pressure when the steam enters from the inside.

Inter alia, the Danek and Fouquemberg valves (Figs. 50 and 51 respectively) belong to the second class. Fig. 50 shows that the "positive" valve, *m*, and the "negative" valve, *n*, are combined in the same piece. The valve-rod must be capable of turning so far on its own axis as to admit of either *m* or *n* being brought into position over *a* or *e*. From the direction of the arrows, it will be seen how this movement immediately effects the converse steam distribution and causes the reversal of the piston movement. In Fig. 51 a movable valve-plate is arranged. The chambers 1 and 2 of the distributing valve communicate with the cavity, 5, whilst 3 and 4 communicate with the live steam. In the position shown, the piston moves towards the right; but on pushing the valve-plate to the left, the steam is admitted to the right face of the piston *via* 4—*y*—*c*, the exhaust passing away to the left through *a*—*x*—1—5, and the piston is driven towards the left.

2. **Valve Gear.**—The short stroke and ready mobility of the valves enable them to be easily and rapidly opened and closed; there is but little resistance to be overcome in reversing, and they

are easily replaced and ground, a circumstance that compensates for the defect that they are liable to hammer extraneous substances into their seat, whereas flat or circular slides simply brush such substances from the surface.

The greatest wear on the valve spindles is produced at the part

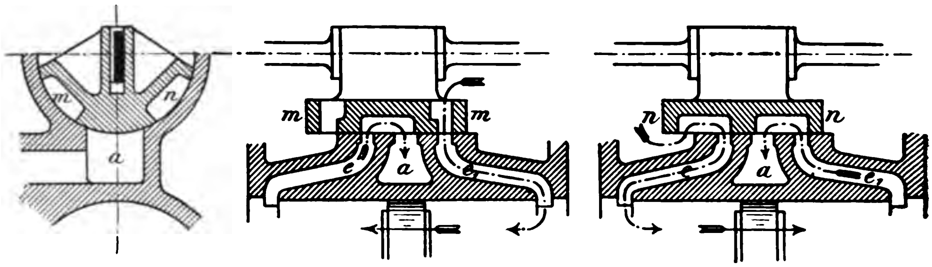


Fig. 50.

corresponding to a medium cut-off. If the engine is working with full admission (*e.g.*, at starting, etc.), there is a risk of the valve stem jamming in the gland, so that the valve is prevented from closing. On this account it is desirable to provide some means of compelling the valve to close. Cushioning valves of suitable dimensions should

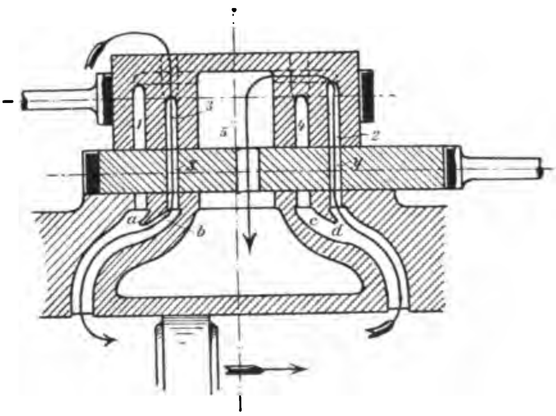


Fig. 51.

be provided at the cylinder heads, in order to prevent a dangerous compression during cushioning, and also to ameliorate water knocks. These valves open into the admission or exhaust pipes.

Arrangement.—An admission and exhaust valve are provided at each end of the cylinder. The valve chests are either bolted on

to the side of the cylinder, so that all four valves are close together,

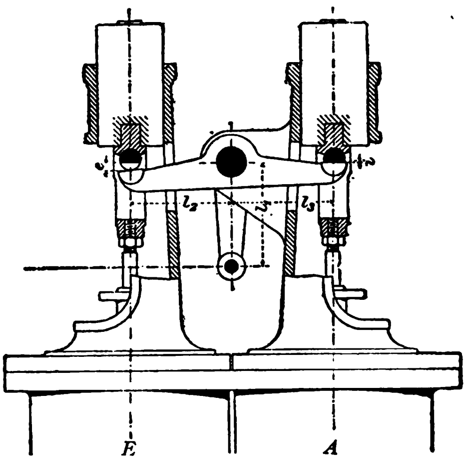


FIG. 52. (*Note.*—E = admission ; A = exhaust.)

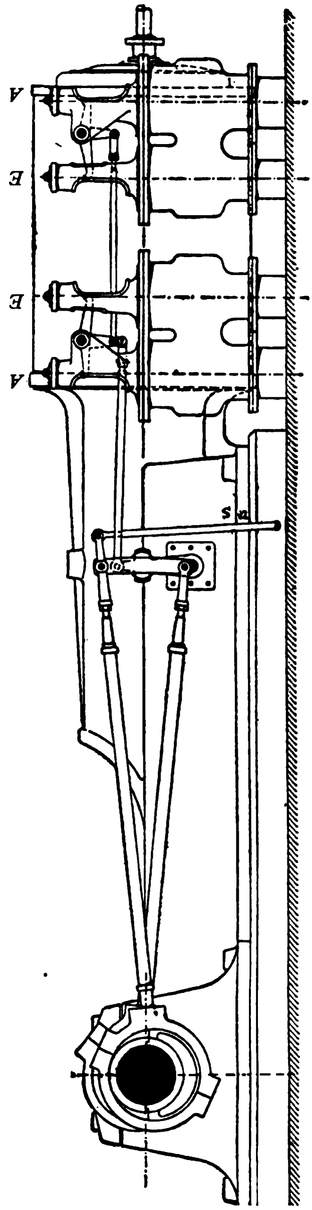


FIG. 53. (*Note.*—E = admission ; A = exhaust.)

on about the same level, and readily accessible; or else the admission valves are situated above, and the exhaust valves in front of,

the cylinder; or, finally, they are arranged in the same manner as in ordinary engines.

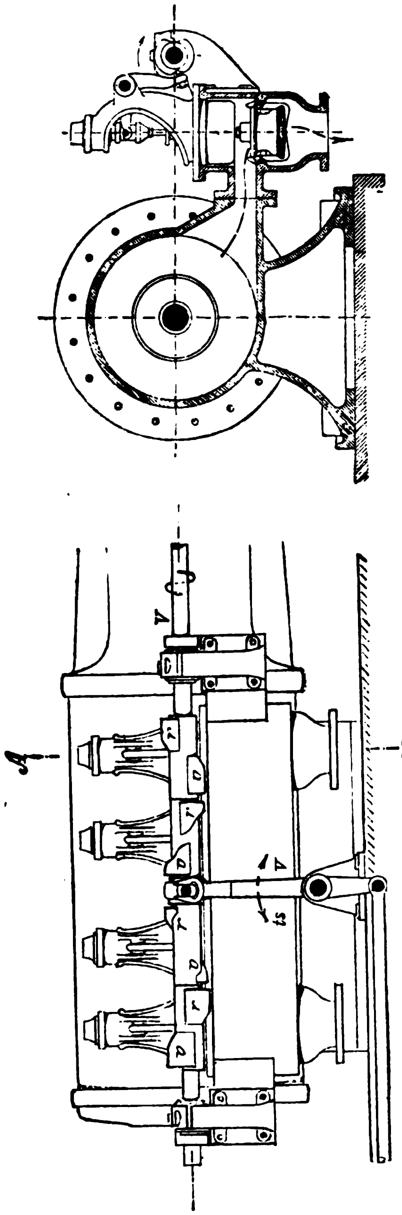


Fig. 54. (*Note.*—*ts* = backwards; *V* = forwards.)

The valves can be actuated from a pivot (Fig. 52), which is controlled by a link (Fig. 53). The distribution is effected in

exactly the same manner as with a link slide valve, though this partly nullifies the advantages of the arrangement; nevertheless, the gear is simple and easily manipulated.

A form of valve gear very largely used is that of Kraft & Brialmont (Fig. 54). A valve shaft in front of the cylinder carries a number of oval collars, which actuate the corresponding valve stems by means of bell-crank levers. The shaft is provided with a feather, on which the collars are adjustable; and each collar is fitted with two contact pieces, V_1 and V_2 (Fig. 55).

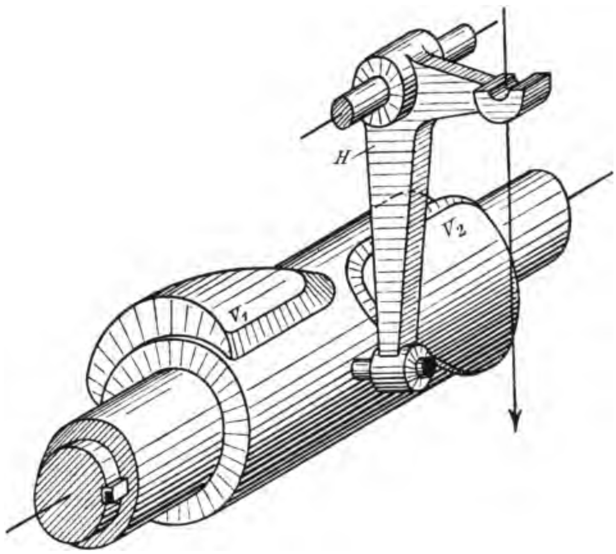


FIG. 55.

These contact pieces act on the cams (studs, or bowls) on the bell-crank lever, H, and open the valve, the reclosing being effected by a spring on the valve stem. When the cam is in the middle between the two contacts, *i.e.*, on the cylindrical part of the collar, then the valves are not raised; but if the collar is slipped to the left or right, then V_1 or V_2 comes into play. The contact pieces are shaped and placed in such a manner that one series is for the forward motion of the engine, and the other for when the engine is reversed. Fig. 56 represents the unrolled surface of an admission valve collar, from which it will be evident at once that, in addition to reversing the engine, an alteration in the cut-off is very easily effected by

this means. The bevelled edge, *a*, of the contact piece opens the valve, which remains in that position until the cam has passed the edge, *a*. Since *a* is parallel to the axis of the shaft, the lead remains unchanged for all positions of the collar, whereas the length of time the valve is kept open, and therefore the cut-off, is increased in proportion as the broader portion of the contact piece is made to act on the cam by sliding the collar. In engines working without rope compensation, and where consequently the consumption of power continually diminishes, it is advisable to correspondingly increase the expansion automatically, since experience teaches that the driver prefers to decrease the efficiency of the engine by throttling the live steam rather than by pulling back the valve-gear lever.

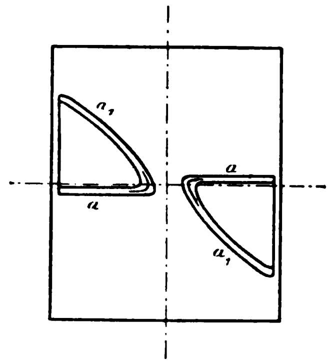


FIG. 56.

This automatic adjustment of the cut-off is effected as follows: The valve-gear shaft terminates in a slow screw thread, which imparts motion to a non-rotating nut, transmitting its own movement to a rotable toothed sector, which is situated directly in front of the gear shaft and can be coupled thereto by a pawl. At the commencement of the trip, the reversing-lever is in its extreme outer position, and if now coupled with the toothed sector, shares the movement of the latter, and thus gradually approaches the middle position, the degree of expansion being increased to a corresponding extent. The reversing-lever can be released at any moment, so that the controllability of the engine is not prejudiced in any way by the adoption of this contrivance.

As a defect of this gear it may be mentioned that, in course of time, the studs or cams grind channels in the collars and thus impede reversing, a supplementary engine being then necessary.

The Radovanovic Parallelogram gear (Fig. 57) is a modification of Klug's reversing gear. The valve shaft carries an eccentric, the

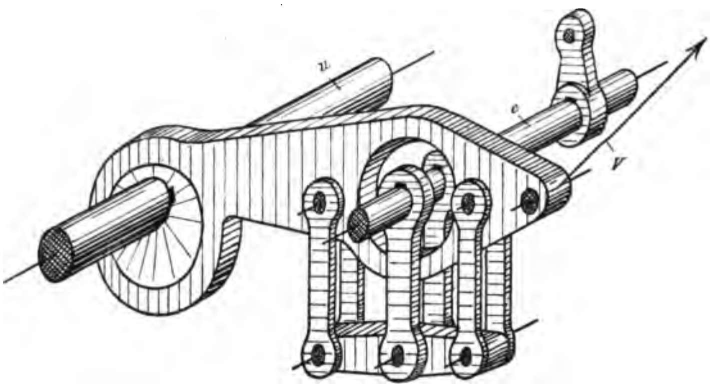


FIG. 57. (*Note.*—*u* = valve shaft; *e* = reversing shaft; V = to the valve.)

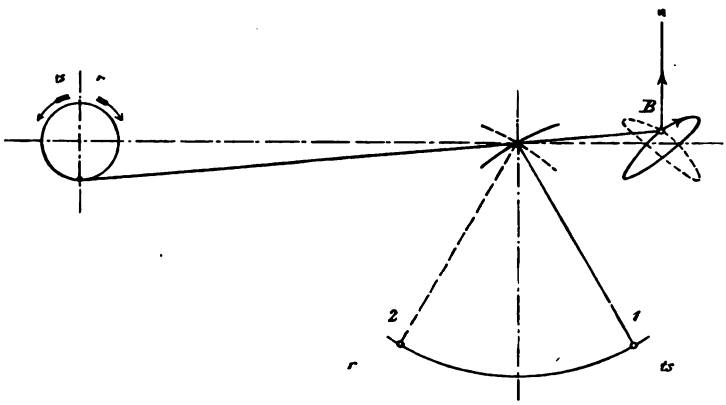


FIG. 58. (*Note.*—*ts* = forwards; *r* = backwards; *z* = to the valve.)

elongated rocker of which actuates the valve. A circular aperture is cut through this rocker, and the centre of this aperture describes an arc, the centre of which can be displaced by turning the valve shaft, with the result that the cut-off is modified. The crank can also be reversed by the same means.

The path of the pin, B, for positions 1 and 2 of the lever, H, is shown in the diagram (Fig. 58).

The perfectly central arrangement of all the parts precludes one-sided wear, reversing is easy, and the steam distribution favourable, especially under high admission pressure, no further disturbance being caused by the increased cushioning resulting from early cut-off.

Winding Drums.

The winding drums take up the rope when rotated by the engine.

Fig. 59 (Plate III.) represents a fast-coupled drum, whilst Fig. 60 shows a portion of a detachable drum, which can be quickly uncoupled from the engine shaft. When it is desired to alter the depth from which the cage has to be raised, the length of the tail rope must be changed whilst the second cage is at rest. The cage worked by the detachable drum is raised to bank, and, the drum being held fast by the brakes, the coupling to the engine shaft is loosened, the engine being then started and the other cage raised or lowered until the desired position is reached ; this done, the loose drum can be coupled up again. Another way is to set the upper cage on the keps, detach the rope, lap it round the drum and fasten it in place, the other cage being then brought into the desired position by the engine.

The detachable drum is attached to the keyed (tangent wedges !) rosette on the engine shaft by bolts, the total shearing strength of which is three times the mean strain they have to withstand. The numerous slots in the rosette enable the position of the drum to be adjusted so as to reduce the shortening of the rope to a minimum and thus avoid slack rope. A more recent form of detachable winding drum, shown in Fig. 61 (Plate IV.), is fitted with wrought-iron spokes and wrought-iron rim. A toothed wheel is keyed on the shaft, and the motion of the shaft is transmitted to the drum by toothed sectors, which can be advanced or drawn back by hand wheels. When the drum is uncoupled the cast-iron hubs run in split metal bushes, which can be easily replaced when worn.

For small drums, friction couplings are also employed.

The rope is fastened to the drum by passing the end through the casing of the latter and lashing it to the shaft or to one of the spokes. As a rule there is no strain on this fastening, the pull of the rope being taken up by the extra turns on the drum.

The weight for counterpoising the reciprocating parts of the engine can be attached to the drum rosettes; and this greatly facilitates uniform slow winding for the inspection of the shaft, etc.

Each wheel of the drum has 6 to 12 spokes properly stayed by St. Andrew's crosses and transverse struts, so that the rope strain is taken up equally between the two.

The drum is faced with oak timbers 2½-5 ins. thick, in which grooves are turned; and recently sheet-iron with a thinner wood lagging, or fluted cast-iron segments, have been used for facing the drums. A section of this latter type of facing is shown in Fig. 62.

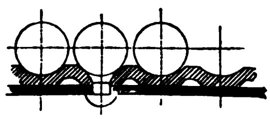


FIG. 62.

Dimensions.—Diameter according to the thickness of the rope; width b—for a single layer of rope—depth of shaft h, drum circumference $2R\pi$, rope thickness d, and number of extra turns n.

$$b = \left(\frac{h}{2R\pi} + n\right) d.$$

b is seldom less than 5 ft., so that for deep shafts R must be considerable, and, under certain circumstances, the injurious overlapping of coils on the drum must be put up with. The strength of the spokes must be based on the maximum rope strain, consisting of the weight of load, cage, and length of rope paid out. Furthermore, the spokes must be capable of standing the extra strain ensuing should the rope break.

Compensating Weight of Rope.

In deep shafts the weight of rope to be lifted at the commencement of the cage trip is an important factor. Powerful

machines are needed, but, since the work to be done decreases in proportion as the weight of the descending cage comes into play, the cut-off must be progressively accelerated or the steam pressure reduced. However, as engines of constant power are more economical in work and can be more efficiently controlled, it becomes desirable to compensate the resistances, an effect obtained by the following means:—

1. By weights that act with the engine during the first part of the trip, but against it in the second half (tail rope, Gerhard's compensation, etc.).

2. By modifying the effective radius of the winding drum (conical drums and bobbin pulleys).

3. By storing up (*e.g.*, by means of pumps and accumulators) the surplus power of the engine during the second half of the trip, and utilising the same during the first half of the succeeding trip. This method, however, is not used.

The most important in the first group of methods is that of compensating by means of the

Tail Rope.—To the bottom of each cage is attached a rope of equal weight, per unit length, with the winding rope, and hanging down in the shaft to a depth exceeding that of the lowest pit eye. Thus, during the whole of the trip a uniform length (and therefore weight) of rope is in action, and the compensation is therefore complete. The defects of this system are the great weight to be moved, the dangerous swinging of the tail rope in winding at high speed, the difficulty of looking after the tail rope, the heavier load on the winding drum shaft, and the heavier strain imposed on the rope cap, which has to bear the weight of the tail rope in addition to that of the cage and load. In the event of the rope breaking, the safety catch must be strong enough to support the additional load entailed by the presence of the tail rope. Moreover, since, when a tail rope is used, the strain is uniform at all portions of the rope, tapered winding ropes cannot be employed, and consequently tail ropes are only suitable for shallow or medium shafts, though for these the system is the simplest possible means of compensating the resistances, especially when the winding is confined to one level.

Tail ropes may consist of old winding rope, flat rope, or aloe-fibre rope, the last named, for instance, when the rope pulleys are close together, and where consequently the rope has to form a small loop. In some cases partial compensation is employed, the tail rope being lighter per unit length than the winding rope.

With a view to winding from different depths, the main and tail ropes are often connected in the following manner:—

The main rope, instead of terminating immediately above the cage, is passed right down through the latter, so as to leave a long piece hanging, which is then connected with the tail rope by a loop and spring gland, the attachment of the cage to the main

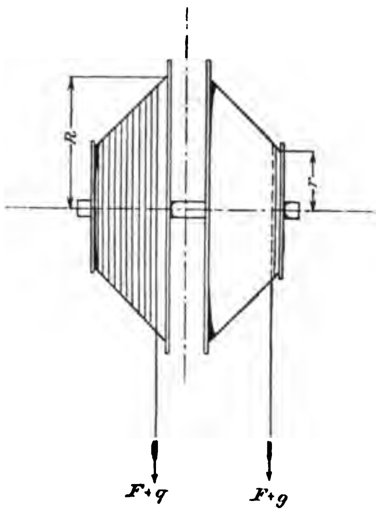


FIG. 63.

rope being effected, *e.g.*, by a Baumann rope clamp. To adjust the cage for winding perhaps from a higher level, the cage at bank is detached from the rope, and the second cage raised to the higher level in question, the rope at the same time running freely through the clamp of the stationary cage, which is afterwards connected up again by the clamp.

For very shallow depths the rope may be replaced by a chain, each cage carrying a piece of tail chain, which gradually coils on the shaft bottom as the cage descends, and *vice versâ*.

Conical or Taper Drums.—Tapered drums are shown in Fig. 63. As the loaded rope ascends and the empty one descends, the

leverage of the drum radius on which the load acts is increased, the weight of the rope being at the same time diminished by coiling on the drum. The converse effect—reduction of the leverage and increase in the weight of the rope—takes place in the empty rope. Provided the proper taper be given to the drum, the moment of rotation, and therefore the resistance to be overcome, remains unaltered. Perfect compensation, however, is not attainable by the use of any conical drum, a rotating body of somewhat sinuous contour being necessary for this purpose.

In approximate calculations, the condition of uniform static moments at the beginning and end of the trip must be taken as a basis.

Commencement of the trip, empty cage at bank.

The unwinding rope, weighing G, and loaded with $q + F$, acts on the radius r; the rope of the empty cage acts on the radius R. Hence the initial moment $= (q + F + G)\,r - FR$.

End of trip, full cage at bank.

Empty cage F and weight of rope G on radius r, loaded cage $q + F$ on radius R (Fig. 63).

Hence the final moment $= (q + F)\,R - (F + G)\,r$.

On posing these two moments as equal, we have:—

$$(q + F + G)\,r - F \times R = (q + F)\,R - (F + G)\,r,$$

whence

$$R = r\left(1 + \frac{2G}{q + 2F}\right),$$

r is selected in accordance with the rope diameter, and R is determined from the foregoing equation; the mean radius $\varrho = \frac{R + r}{2}$, and the depth, H, of shaft furnish the number of coils $Z = \frac{H}{2\varrho\pi}$. Let b be the breadth of the drum and e the distance between two coils of the rope, both measured parallel to the axis of the drum, then $b = Ze$. To take up the extra coils the drum is widened as a cylinder at the smaller end. In the case of deep shafts the rope diameter is large, and therefore also the values r and R; the drums have to be very broad, overlapping of the coils

being impracticable, and hence this method of compensation is only suitable for medium depths (1400-2000 ft.). For greater depths it is necessary, in order to obtain shorter and lighter axles, to mount the drums separately, and couple them by cog gear or coupling-rods, as is done with the driving wheels of locomotives. The defect of the tapered drum system is the variable winding velocity under constant engine speed.

For the same reason, the mean winding velocity is smaller for any maximum velocity than is the case with cylindrical drums.

R′ is often assumed as smaller than would result from the above equation, partial compensation being then accepted as satisfactory. If the pitch of the cone, relative to the axis, exceed 30°, the coils of the rope no longer lay evenly side by side in the spiral

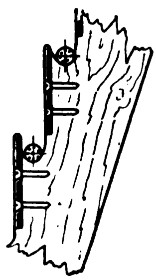


FIG. 64*a*.

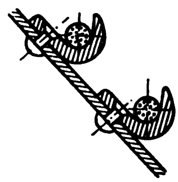


FIG. 64*b*.

groove on the drum casing, but the correct laying of the rope must be secured by the provision of partition walls. These drums are termed spiral drums, different forms of which are shown in Figs. 64*a* and 64*b*.

In other respects tapered drums differ but slightly from those of cylindrical form.

Flanged Pulleys.—These are used instead of drums for flat ropes. They consist of a small core (Fig. 65) bounded by two wheels or flanges, between which the separate coils of the flat rope are wound one on the other. Hence the leverage of rope tension increases on the ascending rope, whilst the rope on the descending empty cage unwinds from a core of progressively diminishing diameter.

For the condition of equal moments at the beginning and end

of the trip the equation $R = r\left(1 + \frac{2G}{q + 2F}\right)$ again applies; moreover, the thickness of the rope paid out and wound up is the same, and therefore $R^2 \pi - r^2 \pi = Hd$ (H representing the depth of the shaft and d the thickness of the rope).

Assuming $1 + \frac{2G}{q + 2F} = A$, and therefore $R = Ar$, we have

$$r^2A^2\pi - r^2\pi = Hd, \text{ and } r = \sqrt{\frac{Hd}{\pi(A^2 - 1)}}.$$

If, from this equation, r works out smaller than appears desirable in view of the thickness of the rope, one must be content with partial compensation, increasing the value of r and determining R from the equation $R^2 \pi - r^2 \pi = Hd$.

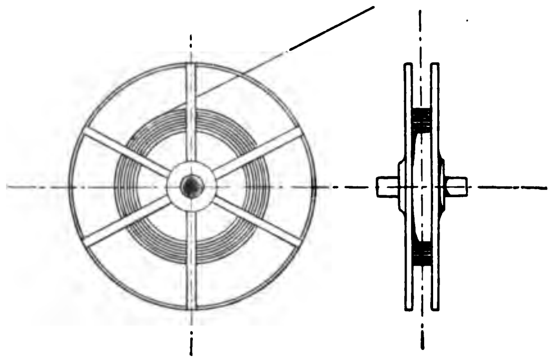


FIG. 65.

A considerable alteration in the resistance during winding occurs in the case of tapered drums and flanged pulleys with partial compensation; but, at all events, it remains of positive value, and there is therefore no need to apply the brakes or reverse the steam admission during the second half of the trip.

Fig. 66 shows a flanged pulley, with a core divided into four sections, to which are bolted wooden spokes forming wheels or flanges that diverge somewhat at the rims, in order to secure a better guiding of the rope. The rims consist of cast-iron segments. If the wooden spokes be replaced with profile iron, it is advisable, in order to protect the rope, to provide an inner lining of wood, or flat bars with rounded edges. In contradistinction to tapered drums, flanged pulleys are very unsuitable for taper ropes, the

outer windings of the diminished rope leaving too much play

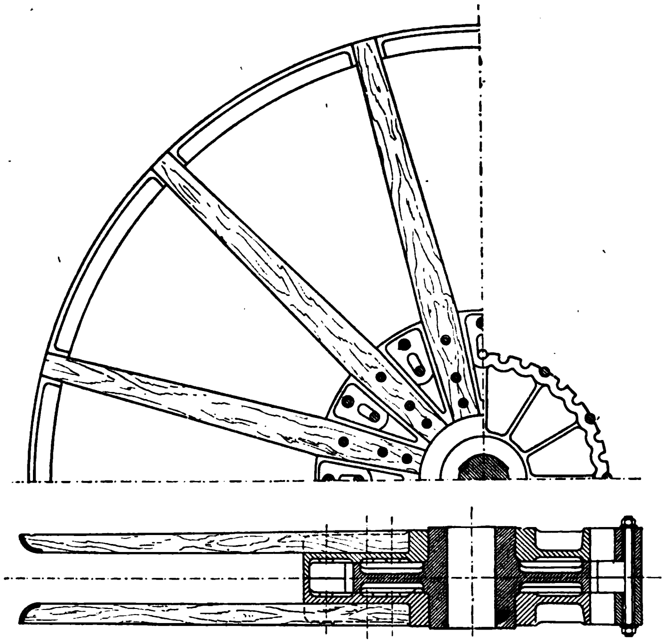


FIG. 66.

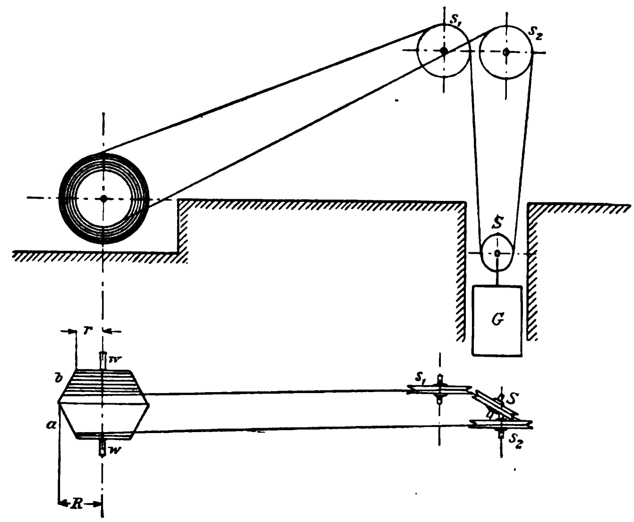


FIG. 67.

between the wheels or flanges. The advantages of flat ropes—

great flexibility and little tendency to twist—are a point in favour of flanged pulleys, and the latter can be placed in close proximity to the head pulleys, because the path of the rope remains constant. On the other hand, the strain on flat rope is very unfavourable, the inner coils being strongly compressed by the overlying ones, the life is shorter, and the load per unit of sectional area must be fixed at a low figure from the commencement. In the case of very deep shafts one must be content with partial compensation, the calculation furnishing, for the diameter of the core, figures that seem inadmissible, having regard to the flexion of the rope. Now that the comparatively light, cylindrical or taper ropes of patent crucible cast-steel, with high tensile strength, are almost exclusively used, and the construction of properly controllable engines, economical in working, and with variable expansion, has become possible, flanged pulleys are disappearing.

Compensating by means of weights is a plan devoid of the necessary simplicity, and moreover is costly to instal, so that only one example need be given, namely, that of Gerhard, illustrated in Fig. 67. The shaft, w, which carries two tapered drums, is coupled direct to the driving shaft. One rope passes from b over s_1, S and s_2, back to a, and suspended from S is a heavy weight, G (consisting of, *e.g.*, an old boiler filled with pieces of cast-iron), which moves in a shallow supplementary shaft. At the beginning of the cage trip, more rope unwinds from b than is taken up by a, and therefore the weight descends; in the second half of the trip, a coils up more rope than is paid out by b, and the weight, G, is therefore lifted. At the start the moment RG − rG assists the movement, whilst towards the end an equal moment exerts a retarding action.

Brakes.

Every engine must be fitted with reliable appliances for retarding the velocity of winding, promptly checking the motion, and arresting the cage in any desired position. This appliance comes into action: towards the end of the upward trip; in case of accident; when the shaft or piping is being inspected or repaired, etc.; and as soon as the weight of the descending cage preponder-

ates. Such a condition may arise when the miners are being brought up in the cage, pit timbers are being lowered, etc.; and also, in deep shafts, owing to the surplus weight of the rope (during the second half of the trip). The engine could be checked by reversing the admission of steam, but this would not suffice to retain the cage firmly in any desired position, and, moreover, control over the winding drum would be lost in the event of breakage of any part of the engine between the drum shaft and the piston. Hence the necessity for providing brakes, usually two in number, one an emergency brake, acting quickly and energetically in case of accident, whilst the ordinary brake is of lighter construction. In the case of double-cylinder engines, under proper control, the second brake may be dispensed with. Two kinds of brake are used: band brakes and block or cheek brakes. The brake wheel can be advantageously attached direct to the winding drum; but in some cases special brake pulleys are provided, especially with flanged pulleys, or the crank disc is utilised in the case of small winches.

Cheek Brakes.—The simplest form of this class of brake, as used for holding the loose drum, is shown in Fig. 68, the wooden brake cheeks, or blocks, being forced tightly against the rim of the drum by means of the hand wheel, screw spindle and brake lever. The friction fD produced by the normal pressure D checks the movement of the shaft.

The brake cheeks are let into and bolted to the lever; when greater force is in question, the cheeks are held in place by suitable iron plates, or bedded in a special cast-iron box. The wood should be cut across the grain so that the ends of the fibres come in contact with the drum rim. The brake lever is made of a heavy beam of timber, or a profile iron girder. The section of the brake rim is shown in Figs. 60 and 61 (Plates III. and IV.). Fig. 69 represents a brake for large engines, the double cheeks exerting a powerful retarding force and obviating one-sided pressure on the drum shaft. The diverging levers tend to throw the brake off automatically. As is shown in Fig. 61, such brakes often act on two rims on the inner side of the drum.

Calculation for Cheek Brakes.—For the emergency brake, which

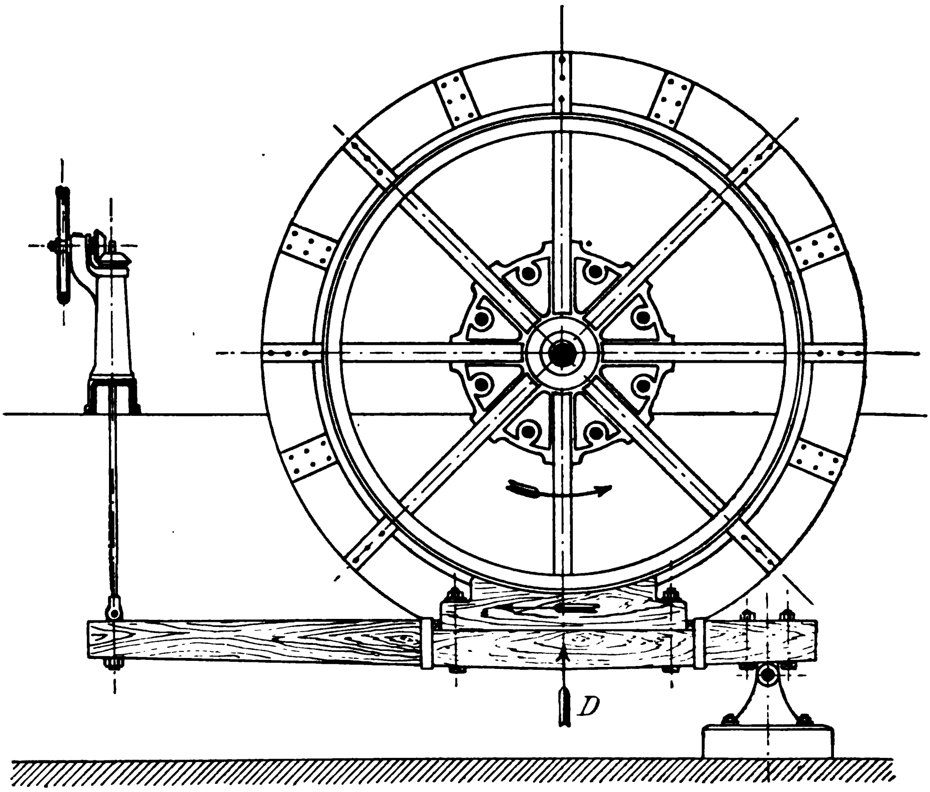


FIG. 68.

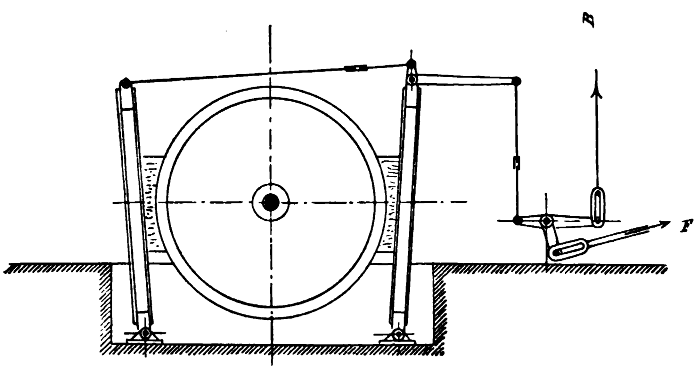


FIG. 69. (*Note.*—B = to brake piston ; F = to hand or foot brake.)

must be capable of supporting the second cage in the event of the

winding rope breaking, and also be able to quickly stop the engine when danger or overwinding arises, the equation

$$P = 1{\cdot}5\ (q + F + G)\frac{R}{r}$$

may be set out, wherein R is the radius of the winding drum, r the radius of the brake rim, q the load to be raised, F the weight of the cage, and G the weight of the rope.

For flanged pulleys and tapered drums, the same value may be taken—loaded cage at the pit eye—or else $P = 1{\cdot}5\ (q + F)\ \frac{R_1}{r}$, in which R_1 represents the maximum radius of the coils.

For ordinary brakes it is sufficient to assume the retardive tangential resistance as $P = (q + G)\ \frac{R}{r}$. From what has been already stated, P is $= fD$, wherein f is the coefficient of friction (0·5 for wood on iron), and D the normal pressure of the brake beam against the rim.

When a safety appliance for the prevention of overwinding is present (*q.v.*), the brake must be capable of stopping the engine and cage within a certain definite distance, s, usually 30-50 yds. The braking effect exerted on the rim of the drum must then be equal to $s\ (q + F + G)$, increased by the *vis viva* of all the moving parts.

Band Brakes.—In this form of brake a band of hoop-iron or steel surrounds a portion of the brake rim, and can be tightened by means of a bell-crank lever. The brake is often lined with wood, to increase the friction and protect the iron band; and, to compensate for wear and tear, at least one end of the band must be mounted so as to allow of adjustment. Since the normal position of the brake is "off," the lever must be counteracted by a counterpoise or spring.

Calculation for Band Brakes (Fig. 70).—If S and S_1 represent the tension in the end portions of a band brake, surrounding the arc a of a pulley with the radius R, then for the direction of rotation I we obtain the relation: $S = S_1\ e^{fa}$, in which e is the basis of the natural logarithm, f the coefficient of friction (0·5 for wood on iron,

and 0·12-0·2 for iron on iron). The tangential resistance, P, opposing movement is S – S_1. This furnishes: $S_1 = \frac{P}{e^{fa} - 1}$; for $a = 0{\cdot}8\ \pi$ and $f = 0{\cdot}5$, $e^{fa} = 3{\cdot}513$. Hence, $S_1 = 0{\cdot}4$ P, and $S_1 = 1{\cdot}4$ P. It is therefore sufficient to produce in the left-hand portion of the band a tension of 0·4 P. At the next trip of the cages the direction of rotation is changed, the smaller tension S_1 being shifted to the right end of the band, whilst a force of 1·4 P must be applied to the left end in order to produce the same effect. Assuming the maximum pressure exerted by the foot at *t* to be 70 units of weight, then: $tc\ 70 = cb\ S$; the leverage ratio $\frac{tc}{bc}$ must therefore be $= \frac{S}{70} = 0{\cdot}02$ P.

If, however, when the direction of motion is 1, the machinist

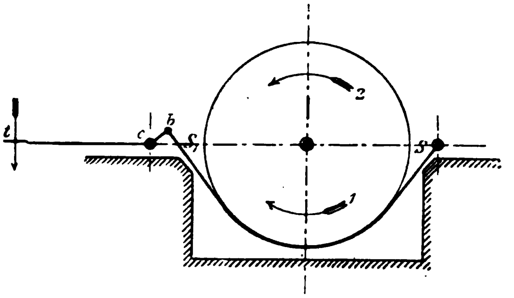


FIG. 70.

erroneously applies a pressure of 70 weight units to the lever, then the tension in the right extremity of the brake band increases to about 5 P, and consequently provision must be made for the band and its fastenings to stand this tension.

The braking effect increases with the dimensions of the arc enclosed by the brake band. In Fig. 70*a*, $a = 1{\cdot}6\ \pi$, hence $e^{fa} = 12{\cdot}35$, S_1 merely $= 0{\cdot}088$ P, and S $= 1{\cdot}088$ P. The leverage ratio becomes smaller, but the tension at the end *c* may increase to 14 P. A far more satisfactory arrangement, therefore, is that shown in Fig. 71, representing a double brake, in which each of the bands has only to produce one-half the resistance: *i.e.*, $S_1 = 0{\cdot}2$ P, and S $= 0{\cdot}7$ P. The bands are usually drawn back from the rim by means of weights or springs.

The brake lever may be moved by hand, with the foot, by

weights or springs, steam, compressed air, electro-magnets, etc. To enable the brakes to be kept "on" for some considerable time, a locking device must be provided when the levers are worked by hand or the foot. Hand wheels, though sometimes used for applying the brakes, are too slow for emergencies. To produce a powerful effect with hand or foot brakes, a high ratio of leverage is

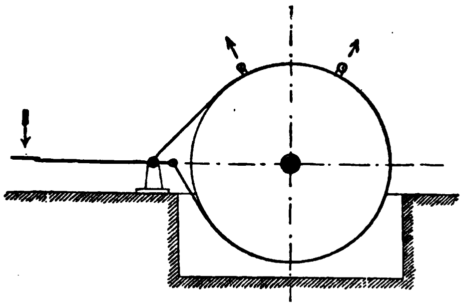


FIG. 70*a*.

necessary, and consequently the levers have to be made very long, even when the blocks are set within a fraction of an inch of the rim.

Steam Brakes.—Steam brakes are powerful and quick in acting, but the suddenness with which they act at full force is injurious to the machine. Furthermore, since steam brakes could not be applied in the event of the main steam pipe bursting, it seems

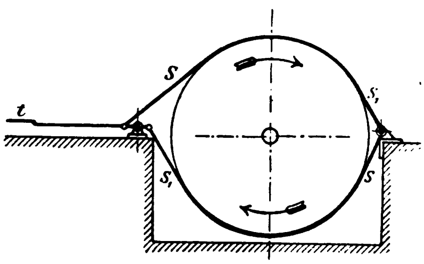


FIG. 71.

advisable to employ a separate supply pipe for conveying steam to the brake cylinder, or else to arrange a heavy weight, which is released in the event of a breakage of the steam pipes, and acts with a high leverage against the brake lever. The cylinder and valve chest of a steam brake are illustrated in Fig. 72, the position of the piston corresponding to "brakes off". Both sides of the

cylinder are in communication with the live steam. On drawing the valve slide towards the left, the steam on the right side enters the exhaust, the piston is driven forward and applies the brake. This uninterrupted contact between the piston and the live steam prevents the disturbances arising from condensation on the admission of steam in the ordinary way. Provision is also usually made

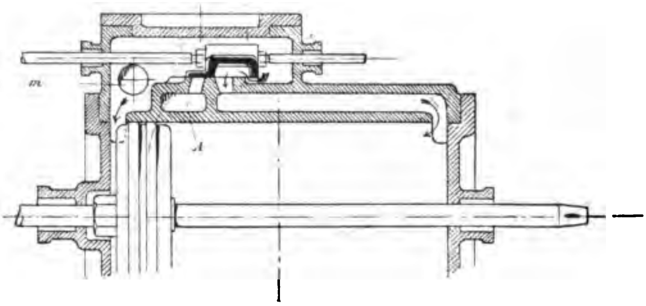


FIG. 72. (*Note.*—*m* = admission ; A = exhaust.)

for setting on the steam brake by hand (see Fig. 69). The vacuum and pneumatic brakes, that have proved so useful in railway work, are now also often met with in winding engines. They enable the checking to be effected gently, with the desired power, and obviate the dangers that might arise from the deposition of water in the cylinders of steam brakes.

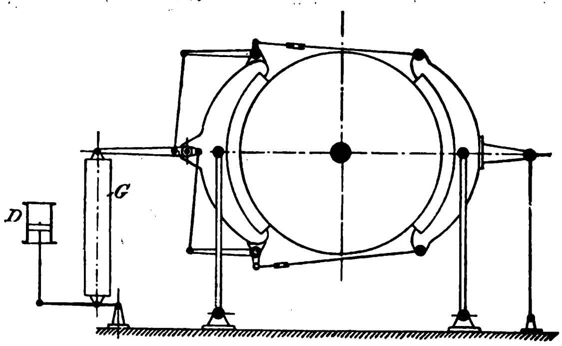


FIG. 73.

Loaded Brakes are also met with, heavy weights, acting at a high leverage against the brake cheeks, being employed. To set the brakes off, the weights are lifted by steam or compressed air. An American brake of this class is represented in Fig. 73, G being the weight and D the steam cylinder for raising same.

Braking by Reversing the Engine.—If the reversing-lever be turned over while the engine is running, the latter acts as a consumer instead of a producer of power, inasmuch as it draws in air through the exhaust and forces it into the boiler. According to Audemar, the defects attending this practice (overheating the cylinder by the high temperature resulting from the compression of the air, and the attainment of a dangerously high pressure in the boiler) can be obviated by placing the exhaust in communication with a large vessel in which the steam and hot condensed water collect. When the engine is reversed, a throttle or non-return valve enables the free sectional area of the pipe between the cylinder and the said vessel to be reduced to very small dimensions; and, in this event, attenuated steam, instead of air, is returned to the cylinder.

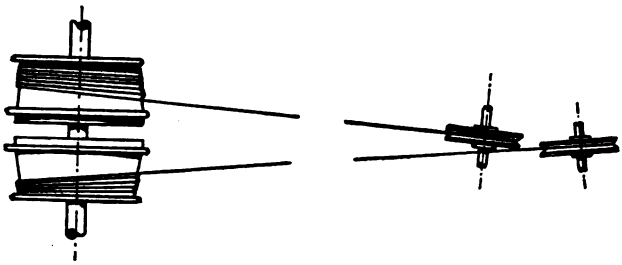


FIG. 74.

Head Pulleys.

As shown in Fig. 46 (Plate II.), the rope passes from the drum over a pulley at a higher level. These pulleys should occupy a position central to the plane of the corresponding drums, and their shafts be mounted parallel to those of the latter. It is seldom that the arrangement represented in Fig. 74 is resorted to in order to ensure a better coiling of the rope by making the drum faces slightly conical. To reduce the risk of the cage coming in contact with the head pulley in the event of overwinding, the latter must be mounted at a sufficient altitude above bank, the distances averaging 10-40 yds., according to the working velocity, diameter of the drums, and height of the cages. The distance between the drum and the head pulley is usually 25-50 times the breadth of the drum, and should

be sufficiently great to ensure the turns of the rope lying uniformly side by side. If the distance be too small, the rope is subjected to injurious friction against the pulley flange in consequence of the high deviation from the central line; whilst if too far away, an in-

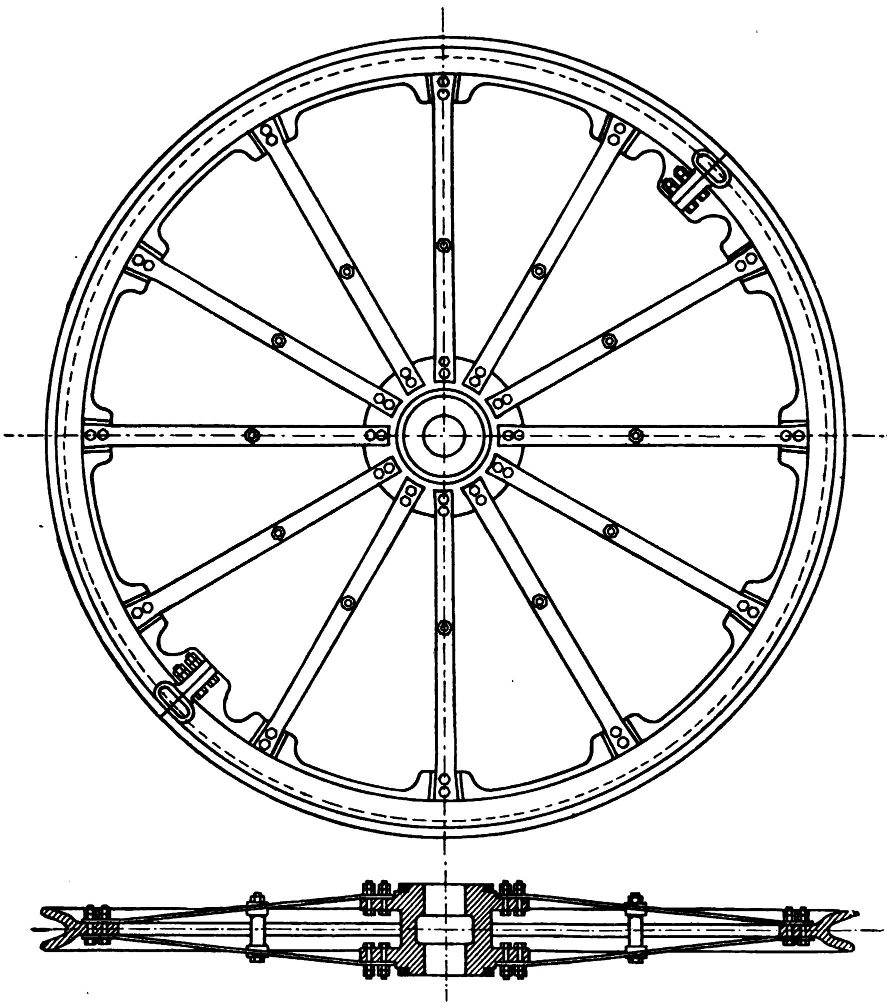


FIG. 75.

convenient swinging of the rope is produced. In the case of flanged winding pulleys, the distance may be reduced to any convenient extent.

The diameter of head pulleys depends on the thickness of winding rope used. The pulley shaft should be as long as possible,

and the supports firm and well stayed, to resist the lateral strains produced by the rope. The shafts and journals must be selected in accordance with the tension in the ascending and descending ropes, and the weight of the pulleys themselves. The rope tension to be considered is the breaking strain of same.

Construction.—Small pulleys cast in one piece, divided hub, spokes of oval, X or H section; large pulleys in two or more sections, the spokes being often of wrought-iron (round bars, gas-pipe, flat rods, U-iron, etc.). Round spokes are cast into the hub and rim, flat or profile spokes bolted as shown in Fig. 75. The groove in

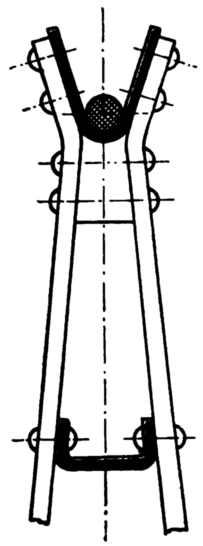


FIG. 76.

the rim should be deep and V-shaped, the base being of thick metal to allow for wear. The amount of wear should be ascertained from time to time, by means of templates, or by holes drilled through the rim for that purpose. The groove is sometimes lined with wood, leather, rubber, hempen rope, etc., but, as these materials will not stand much wear, they are not often used now.

Fig. 76 represents a pulley rim of wrought-iron exclusively.

The pulleys should be as light as possible, so that they may readily adapt themselves to alterations in the speed of winding, and not cause any attrition of the rope in the groove as a result of their

inertia. They should be accurately balanced and run perfectly true Hence, pulleys made in one piece should be turned true after they are keyed on the shaft, those in sections being merely clamped tightly on the shaft by means of the screw bolts on the two halves of the hub.

At one time towers of masonry were used to support the head pulleys, but have now been almost entirely displaced by iron head frames, timber being used only for small shafts or temporary purposes. The lower part of the pulley should be provided with a protecting case, to prevent accident in the event of a breakage of the pulley shaft or of the pulley itself.

The head frame should also project somewhat above the bearings, to enable a crane or crab to be erected for the purpose of lifting the pulley out of the bearings, etc.

Installing the Winding Engine.

Winding engines may be vertical or horizontal, single- or double-cylinder engines, with or without intermediate gear, and with either a common driving shaft for the drums, or with two separate shafts for the latter. Under ordinary circumstances at the present time, the usual form of engine is the direct-action, horizontal, double-cylinder (or compound) type, with cranks set at an angle of 90°. For low-speed work (underground haulage, etc.), single-cylinder engines, or better, double-cylinder engines, with intermediate gear are chosen.

In the present state of constructive engineering, it is possible to make toothed gearing that will work reliably and noiselessly, so that engines with intermediate gear are again coming into the field for winding purposes.

Large vertical engines are rarely met with on the Continent, and separate driving shafts for the drums (Fig. 77) are only required under special local conditions. One advantage of the arrangement shown is that both ropes run overhead from the drums, thus obviating the unfavourable doubling bending of one and the same rope.

Separate drum shafts are also useful with drums of great breadth (p. 56), and where the head pulleys are set close together, since the

deviation from the central plane, otherwise suffered by the rope, is hereby diminished. The constructive details are based on the same fundamental principles as with engines for driving shafting, though greater importance attaches to ease of supervision and the accessibility of all parts. These conditions are secured by high foundations, placing the steam pipes, etc., in well-lighted passageways, placing the levers for starting, reversing and braking the engine at the driver's stand, which should preferably be in such a position as to command a view of the pit bank. The main starting valve

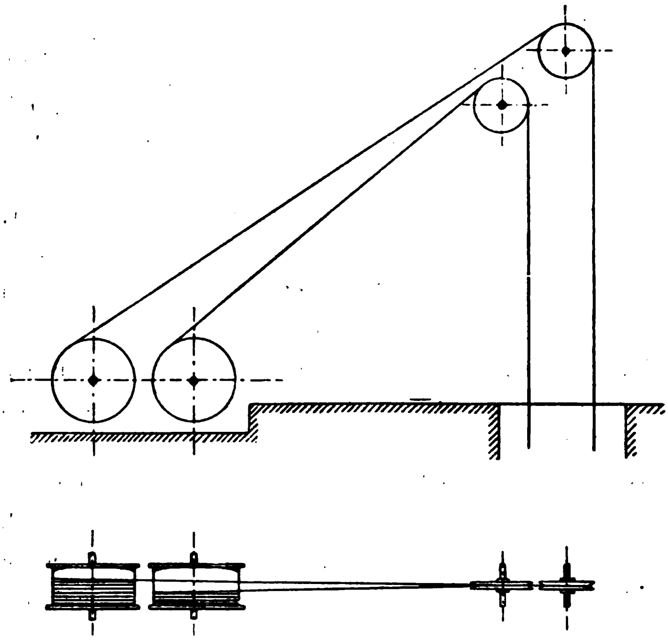


FIG. 77.

should open and close with a single turn, the valve stem being fitted, for this purpose, with a cross bar, the ends of which are guided in a spiral line.

Furthermore, to compel the driver to work with expansion, the starting valve is occasionally done away with, as well as the notches on the quadrant of the valve-lever.

Compound Engines.—These engines produce an economy of 10-20 per cent. in the consumption of steam, a result due, not merely to the acknowledged advantages of the compounding, but

also to the compulsory expansion of steam in the low-pressure cylinder, independently of the working of the valve-lever.

The good effect of compounding is largely reduced, however, by long pauses in working and by considerable fluctuations in the resistance to be overcome; and for deep shafts, without rope compensation, equally favourable results are obtained with double-cylinder engines. Compound engines are less easily controlled, and, on starting, fresh steam must be admitted into the low-pressure cylinder, whilst the waste steam from the small cylinder is conducted to the exhaust. Unless this plan be adopted, it takes a longer time to get up full speed with a compound engine than with a double-cylinder engine of the same horse-power. For specially heavy winding, tandem double-cylinder engines are now constructed.

Condensating is to be recommended where fuel is dear, and the feed water is bad, otherwise necessitating expensive purifying plant, and where there is available at the same time a plentiful supply of water for the condensers.

Spray condensers are the only form coming under consideration for separate engines, but connection with a central condensing plant is preferable.

To prevent the drawing of water into the cylinders, the condensed water may be removed through a barometer tube, or non-return valves are provided in the steam pipes; change valves may also be provided, to enable the engine to work without condensation.

The steam consumption in winding engines is a very variable quantity. In general it may be assumed that 20-65 lb. of feed water are required per hour for each ton raised a height of 330 ft., so that when, for example, 50 tons an hour are raised from 1,000 ft., 1½-4½ tons of feed water will be needed in the same time.

Special Arrangements.

1. **Single-cage Winding.**—Where there is only a single cage, the winding drum is coupled to the non-reversing engine during

the upward trip, the empty cage being lowered by braking the disconnected drums.

2. Koepe Winding Pulley.—The Koepe system of winding (Fig. 78) consists of a pulley, fitted with a single groove and keyed on to the engine shaft, the rope being simply slung round this pulley, and the two ends led up round the head pulleys to the pit. The rope is moved by the friction of the driving pulley, on which account the pulley groove should be lined with leather,

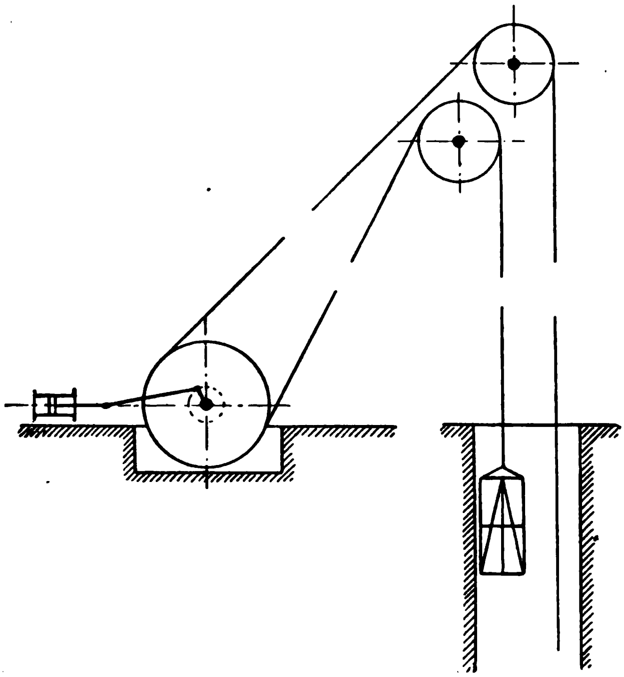


FIG. 78.

oak or white beech wood, and the rope should not be greased. Valuable adjuncts to this method of winding are the use of compensating tail ropes, and Baumann's rope clamps, which enable the cage to be adjusted to different levels for winding. Since overwinding seems impossible, the head pulleys may be situated close above the pit mouth; for when the descending cage is resting on the bottom keps, the tension on that part of the rope is so small, and hence the friction in the pulley groove is so low, that the cage at bank cannot be raised any further, the rope simply

skidding in the groove. The disadvantage of the system is that, should the rope break, both cages will be precipitated down the shaft, and that if one winding compartment is obstructed, the other cannot be used.

In some cases catch ropes have been provided to take up the load of the cage on the breaking of the winding rope, but this causes the system to lose its feature of being cheaper than winding drums.

3. Steam Winches.—This name is applied to small, compact and easily portable winding and hauling engines. The larger winches, such as those constructed by Bolsano, Tedesco & Co., of Schlan (Fig. 79), do not differ greatly from double-cylinder engines with intermediate gear. For small powers, however, vertical engines with oscillating cylinders, internal reversing gear, or change gear for reversing the rotation of the drums, are frequently used.

Fig. 80 shows a pulley winch, and Fig. 81 a horizontal-pulley winch (E. Wolff, Essen), specially adapted for winding from winzes. The position and mounting of the pulley are shown in the Fig.; the power is applied by oscillating cylinders, set at an angle of 90°.

Winding Engine Calculations.

Let F be taken to indicate the weight of the cage, G that of the rope, and q the load to be raised. Since the two cages balance, the initial resistance to motion is $= q + G$, together with the supplementary resistances, reduced to the periphery of the winding drum, say 4 per cent. of the total load, which gives us

$$W_1 = q + G + 0{\cdot}04\,(q + G + 2F).$$

At the end of the up trip, before the descending cage is on the keps, we have

$$W_2 = q - G + 0{\cdot}04\,(q + G + 2F) = W_1 - 2G,$$

and after

$$W_3 = q + F - G + 0{\cdot}04\,(q + G + F).$$

In shallow pits W_3 is the most important value, W_1 where the depth is considerable. (W_3 does not come into consideration when keps are not used and slack rope is entirely avoided.) The average

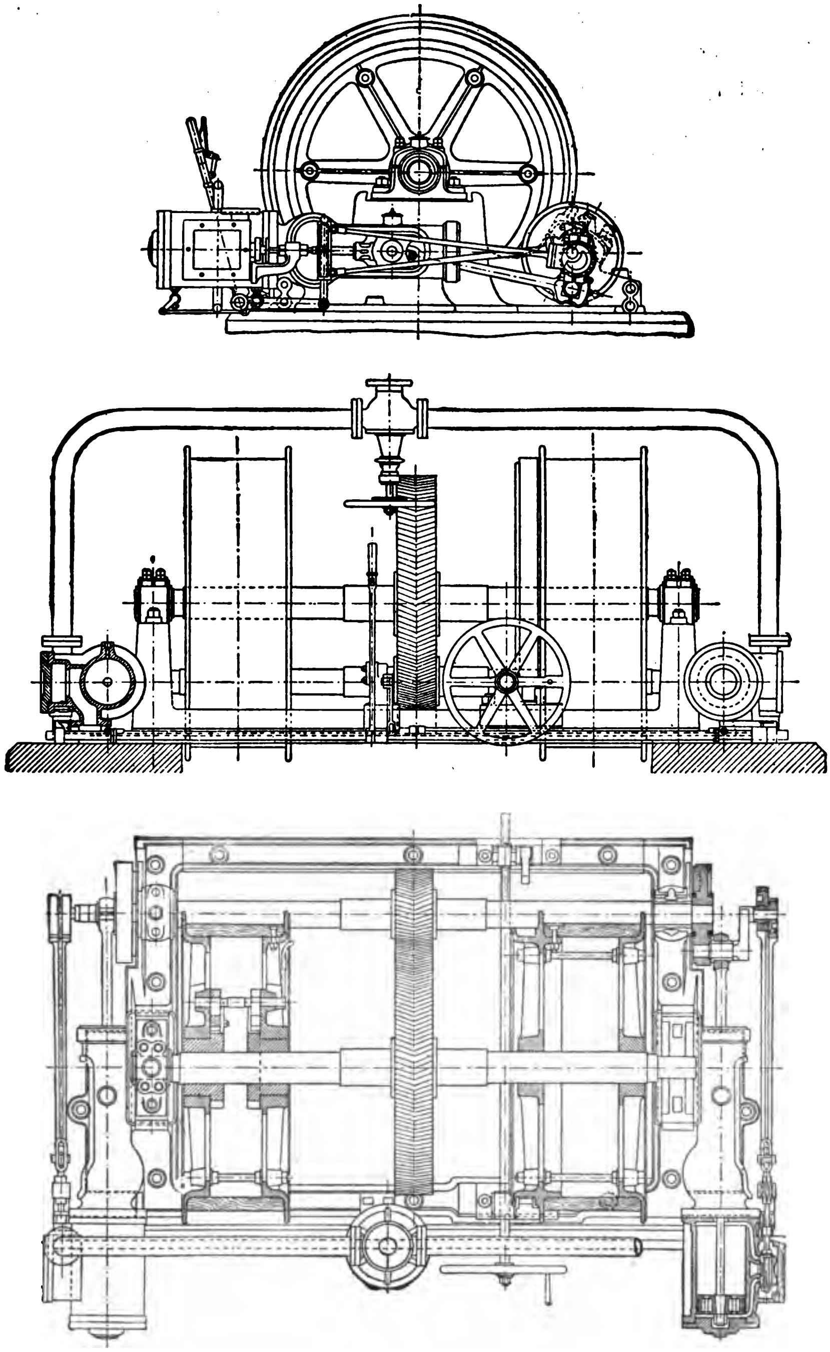


FIG. 79.

cage velocity is 33-43 ft., but the maximum lies much higher. The maximum permitted for winding coal (50-65 ft.) and men (about 13 ft.) is usually fixed by legislative enactments.

For any given velocity, v, the useful effect $N = \frac{Wv}{75}$ h.-p., and

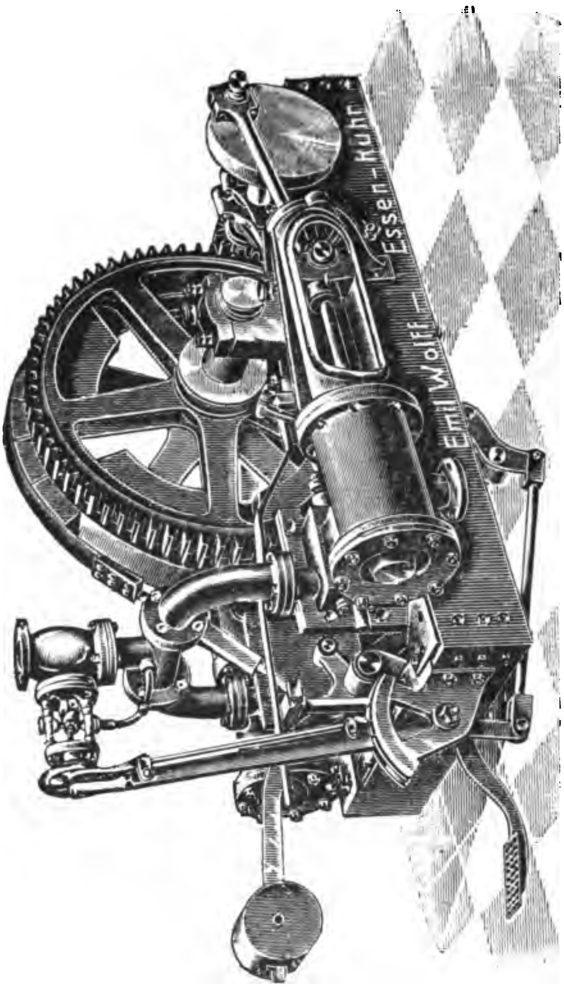


Fig. 80.

from these data the particulars of the engine can be calculated, assuming a certain steam pressure in the boilers, a given cut-off, and an efficiency of 60-70 per cent. In such case the engine will work under full load with full pressure or small expansion, but

under the lowest duty $\frac{W_2 v}{75}$ with high expansion. The medium expansion corresponds (Hrabak) to the economically most advantageous cut-off. In the case of double-cylinder or compound engines, an additional calculation is required to ascertain whether, in the event of the one crank being in an unfavourable position (at the dead point) the engine is still able to lift or hold the load with one

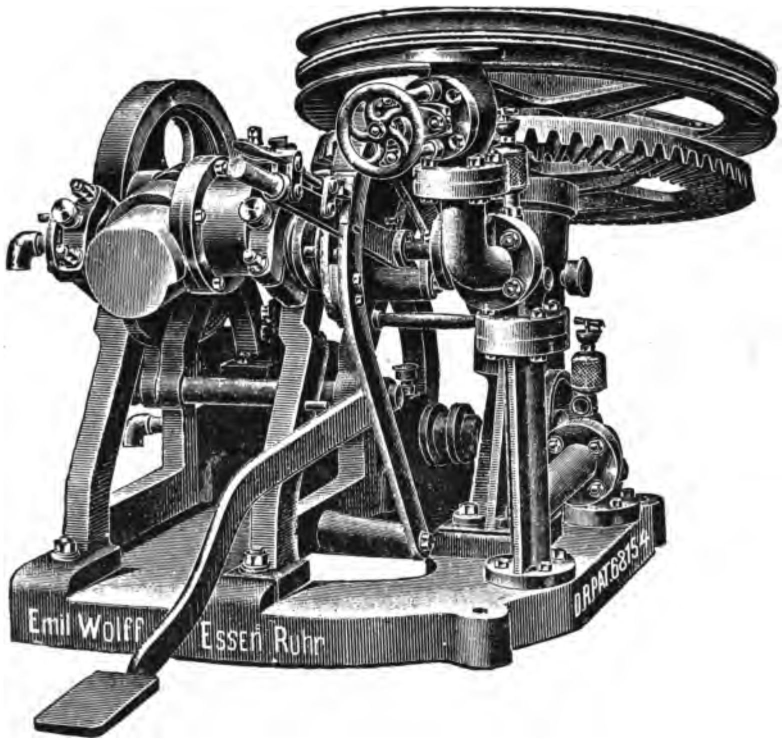


FIG. 81.

cylinder. Another requirement, namely, that the engine shall, in the event of the rope breaking, be capable of raising the loaded cage at uniform velocity from the bottom of the shaft, is really too stringent. To facilitate starting, the valve gear of double-cylinder engines should be so arranged as to permit of the admission of a full head of steam; and in compound engines a direct inlet for fresh steam into the low-pressure cylinder must be provided.

Where the winding traffic is busy, the duration per trip must

be determined from the amount to be raised in the day; also the necessary mean velocity, and the requisite acceleration when it is desired to attain the highest permitted velocity at 30-50 per cent. of the distance traversed. A calculation is then made as to whether the tangential pressure on the crank pins is sufficient to impart this acceleration to all the moving parts.

For engines with tapered drums or flanged pulleys, the approximate calculation is very similar; only the resistances must be referred to a mean radius $\rho = \frac{R + r}{2}$, and the corresponding mean velocity inserted:—

$$W_1 \text{ becomes } = \frac{r(G + F + q) - RF}{\rho},$$

$$W_2 \text{ becomes } = \frac{R(q + F) - r(F + G)}{\rho},$$

$$\text{and } W_3 \text{ becomes } = \frac{R(q + F) - Gr}{\rho}.$$

Moreover, it is advisable to determine the resistances for a few of the intermediate positions, and to calculate whether starting from intermediate levels necessitates a greater output of power. Of course the highest values so obtained must be kept in view.

Signals and Safety Appliances.

The engine driver must be advised when the cages are ready to start, and receive a signal from the pit eye or cage, besides being aware at all times of the exact position of the cages in the shaft.

Signalling is effected by means of a bell or hammer in the engine-room. A cord, or better still, a thin wire, runs down the shaft to the pit eye. Speaking tubes and pipes fitted with whistles are insufficiently reliable; but iron rods, struck by a hammer, will carry sound well, and may be used for signalling from the cage. Latterly the use of electric signals has made headway; and by this means signals can be sent also from the travelling cage to the engine-room. The winding rope can be utilised as one conductor, the other consisting of a copper wire, extending all down the shaft outside the cage, and placed in electrical communication with the latter by a contact piece.

Depth Indicators.—These are appliances for indicating the cage trip on a reduced scale, and thus showing the momentary position of the cage. In one form, motion is transmitted from the drum shaft or valve shaft to two screw spindles carrying travelling nuts attached to a pointer. In order to ensure the proper setting of the pointer when the rope is altered, it is advisable that only one of the spindles should be actuated by the engine shaft, the other being driven from the hub of the detachable drum. The depth indicator, or a separate similar appliance, can also actuate a bell as soon as the cage is within two or three turns of the rope from bank.

A painted mark on the drum indicates the exact position at which the engine must be stopped.

Tachometers.—While on the one hand the permissible maximum velocity must not be exceeded, it is essential on the other to wind as quickly as possible ; consequently some instrument for indicating the velocity of the cage is indispensable. Most tachometers greatly resemble governors in construction, and act on a pointer, usually a pencil which traces the curve of velocity on a revolving paper drum.

Another form of tachometer is a small centrifugal fan, which produces rarefaction of the air in accordance with the speed at which it is run. The rarefaction is measured by a pressure gauge, which indicates the corresponding velocity. Such appliances, however, are dependent on the temperature and barometric pressure of the air.

Overwinding.—A frequent source of accident in winding is overwinding, *i.e.*, the cage being raised too high. The means of prevention are : (*a*) releasing the connection between cage and rope, (*b*) clamping the cage between tie guides, and (*c*) automatically applying the brakes or stopping the engine.

(*a*) *Releasing the Rope.*—Fig. 82 shows the appliance devised for this purpose by Haniel & Lueg, in both positions, open and shut. To the bridle chains are attached shears, consisting of three plates, *a*, against which fit, on either side, the plates, *f*, attached to the rope. The accidental release of the rope when slack is prevented by a copper tube, *c*, the same effect being produced, when

the rope is taut, by the form of the recesses at *h*. When overwinding occurs, the shears enter the funnel-shaped catch, *k*, which is

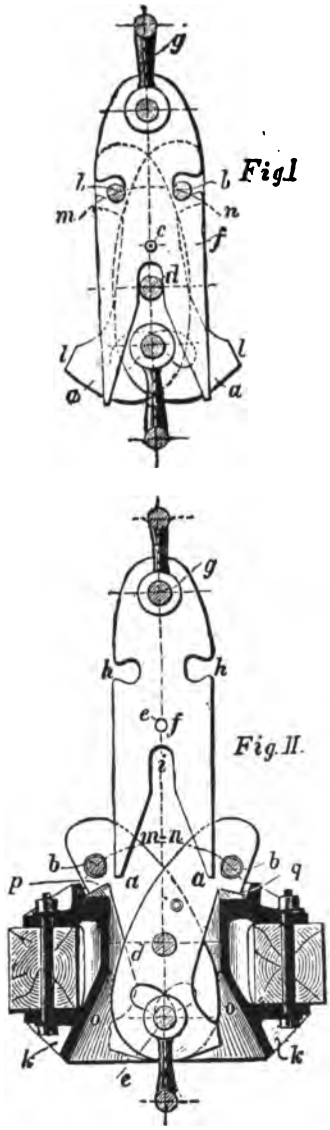


FIG. 82.

situated a little below the head pulley. The connection is broken, the opened shears engage with the steel ring, *q*, and support the cage. As the plates, *f*, are drawn over the head pulley and up to

the drum, it is necessary to interpose a strong partition between the path of the rope and the engine. The appliance just described is one of the best of its kind; but is attended with the disadvantage of requiring careful looking after, owing to the considerable increase in the number of parts in the connection between rope and cage.

(*b*) *Clamping the Cage in the Guides.*—Between the bank and the head pulley the cage guides are drawn somewhat closer together. This method, however, has little to commend it, since either the guides will be forced apart or the rope break. Of course, suitable supports must be provided to catch the cage.

(*c*) *Automatically Stopping the Engine.*—In older appliances the admission valve is shut off and the brakes applied as soon as the cage, and consequently the nut on the depth indicator, rises above a certain height. The nut lifts the pawl restraining a weight, which thereupon falls and effects the stopping of the engine. If the cage passes bank at a moderate speed, this method enables an accident to be prevented, but not when the cage velocity is high. The idea therefore suggests itself of throttling the live steam or the exhaust by means of the ascending nut of the indicator, and thus automatically slowing down the engine before the cage reaches bank. This, however, somewhat interferes with the controllability of the engine at starting, and it therefore seems preferable to prescribe a definite limit of speed at the end of the trip, and to provide for the automatic application of the brakes if that limit be exceeded. At the same time the simultaneous throttling of the steam is often effected; but it must not be forgotten that, in such event, the driver is prevented from reversing the admission of steam.

Of the numerous appliances devised for this purpose (the Roemer, the Mueller, the Westphal, the Wodrada safety appliance, etc.), only that of Baumann will be described here (Fig. 83).

The spindle of the depth indicator imparts longitudinal motion to the non-rotating nut, *i*, whilst the toothed rocker, *a*, is turned by a governor, and, as the speed increases, approaches the nose on the nut, *i*. If now the speed is not sufficiently reduced as the cage nears bank, *i* comes in contact with *a*, the lever, *c*, is turned, *e* is released, and the falling weight, *f*, sets on the brake or throttles the

steam. The same applies when, at any moment during the trip, the projecting piece, *d*, of the rocker, *a*, presses against *c*, and thus releases *g*.

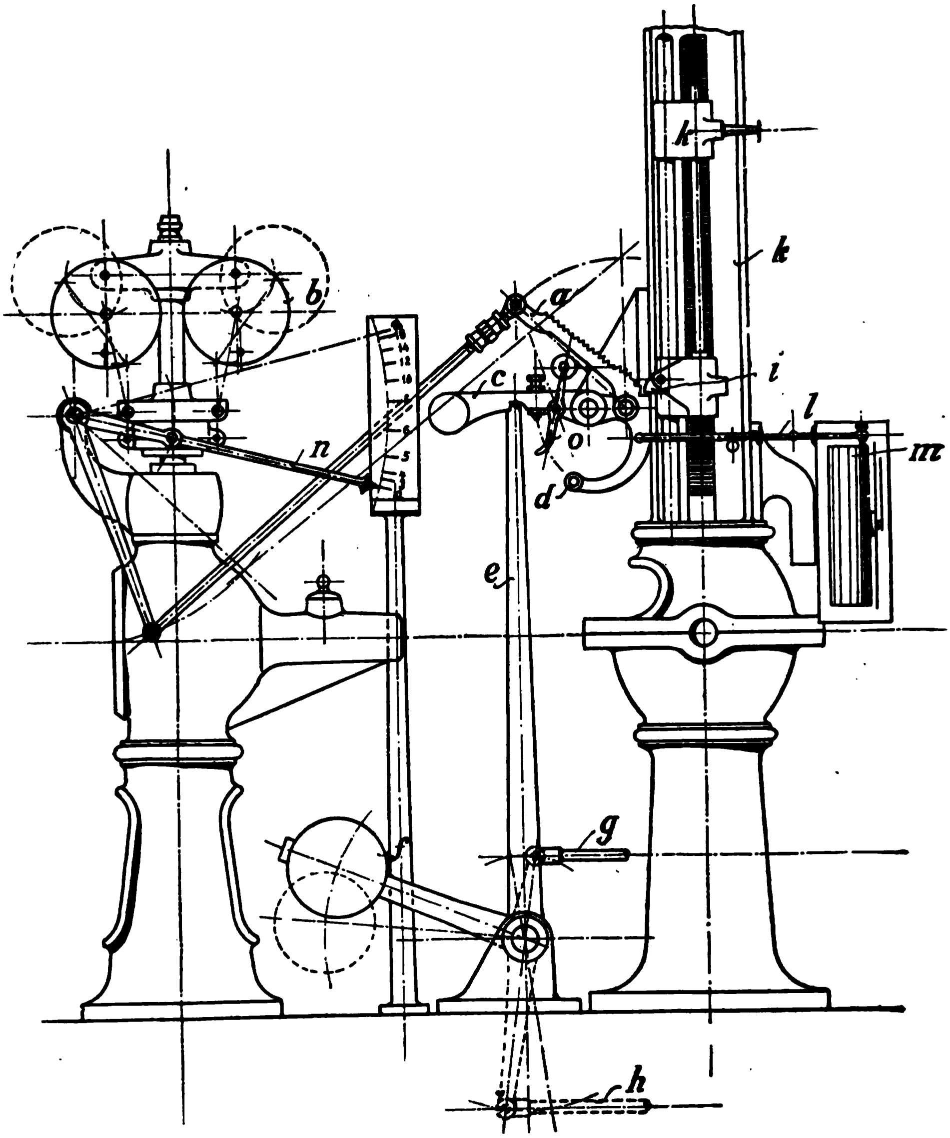


FIG. 83.

For winding the men, in which case the permitted speed is of course much lower, the pivoted lever, *o*, is set in action, thus corre-

spondingly decreasing the distance between *d* and *c*. The governor at the same time serves the purpose of a tachometer, the curves of velocity being recorded by means of the paper drum, *m*.

(*b*) HYDRAULIC ENGINES.

Water wheels and large turbines are now rarely employed directly, preference being given to utilising the water power for generating electricity, and using the latter as the source of power. On the other hand, hydraulic engines, small turbines and Pelton wheels are still largely used. These may be driven by water specially subjected to pressure, water flowing from a higher level, or finally water from the mains. In the latter contingency especially, the cost both of installation and working is low.

Hydraulic Engines

do not differ in principle from steam engines. The admission of water to the cylinder is regulated by plunger valves, slide valves or other forms of valve ; and pistons or plungers are used. The simplest hydraulic motors are fitted with one or two driving cylinders, and work under a full head. Reversing is effected by interchanging the admission and outlet by means of reversing slides or cocks. Of course such motors consume an amount of water equal to the cubical capacity of the cylinder, whether the work to be done be much or little. Hence they work the more economically, and can be constructed the more simply, in proportion as the resistance to be overcome is the less subject to variation ; and consequently hydraulic lifts and winches should always be fitted with good rope compensation. With diminishing resistances, either the shaft must be braked or the water pressure decreased by throttling the admission (or increasing the counter pressure of the waste water). This, however, does not diminish the amount of water consumed. Hydraulic engines may be adapted to fluctuations of load by—

1. Altering the stroke, by adjustable crank pins—a method seldom used, and suitable only for very small engines.

2. Modifying the working surface of the piston, the engine being made with three to twelve pistons, all of which work together

when the load is at its highest, while some of them can be cut out when the work is reduced.

3. Altering the admission. Since water can neither expand nor be compressed, it is insufficient to merely shut off the supply,

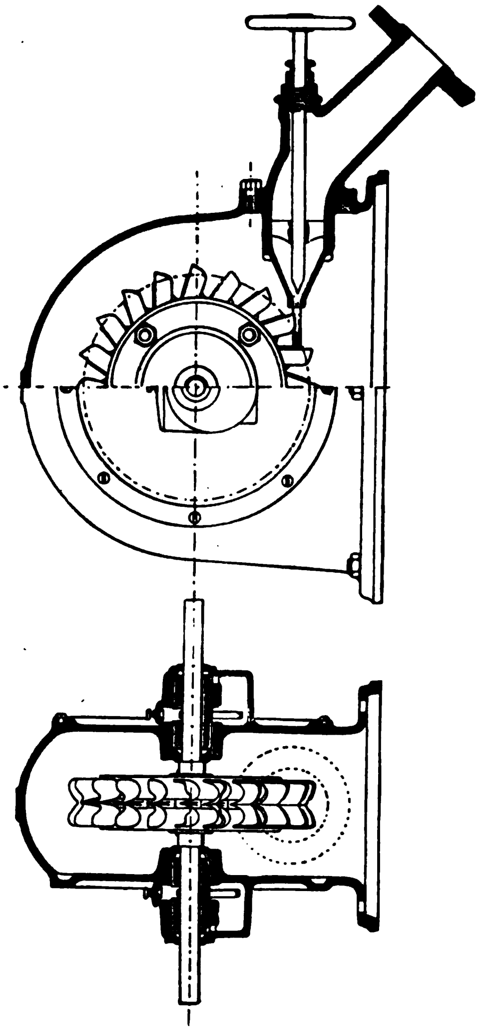


Fig. 84.

since the forward movement of the piston would then lead to the formation of a vacuum in the rear, whilst closing the outlet would result in concussion (water knocks) instead of cushioning in the front end. In order to obviate both evils, one must either—

(*a*) Take the precaution, after shutting the admission valve, to

admit water under ordinary pressure (*e.g.*, from the waste pipe) into the cylinder; and after shutting the outlet allow the water in the cylinder to be forced back into the feed pipe; or

(*b*) Provide large air bags above both ends of the cylinder. On shutting off the feed water, the air in the bag at that end of the cylinder will have the same tension as the water, and will expand in proportion as the piston advances. If the valves have been properly set, the air pressure should recede to that of the atmo-

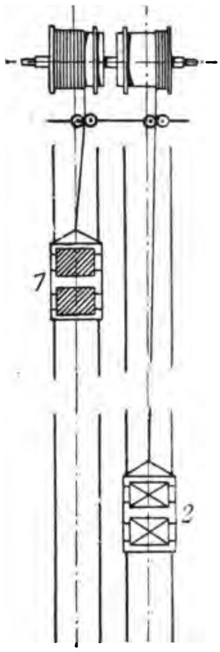


FIG. 87.

sphere by the time the outflow commences. At the close of this stage the air is compressed, and should attain the same pressure as the water by the time the piston has returned to its initial position.

Turbines

are in many respects superior to hydraulic engines, especially the smaller sizes. Compact construction, convenient handling and high efficiency specially characterise the Pelton wheel (Fig. 84), which can easily be arranged to reverse by mounting two wheels, with paddles set in opposite directions, on the one shaft, and

providing two sets of water nozzles (double motor). Figs. 85 and 86 (Plate V.) illustrate a haulage winch driven by a Pelton wheel.

The regulating spindles for closing the nozzles are here attached to pistons working in small cylinders. Each cylinder is fitted with a cock, which enables water to be admitted above or below the piston, thus closing or opening the nozzle. The cocks of the four nozzles are connected with the valve-lever by coupling rods.

Water Tank Hoists.

These hoists are seldom used in vertical shafts, though sometimes employed for working vertical and inclined hoists in open-cast ore mines. The trucks are fitted with water tanks, or special trucks filled with water are attached to the ordinary ones. The arrangement is sketched, diagrammatically, in Fig. 87. Here the truck 1, with filled tubs and empty water tanks, is ascending, whilst truck 2, with full water tanks and empty tubs, is going down. The drums are provided with brake rims, since brakes are necessary almost all through the trip, especially when there is no rope compensation. The brakes are preferably automatic, and the velocity is low. The filling and emptying of the water tanks being attended with loss of time, the system is only suitable for small loads.

(*c*) ELECTRIC WINDING ENGINES AND COMPRESSED AIR ENGINES.

(*See Chapter VII.*)

CHAPTER V.

WINDING WITHOUT ROPES.

THE undeniable defects of rope winding, especially for great depths, have led to numerous endeavours to raise the load direct, without the intervention of any organ of traction.

In this connection, mention may here be made of Blanchet's "pneumatic" system of winding, and the method proposed by Mähnert.

Blanchet inserts in the shaft a pipe (or, for double winding, two pipes), about 60-80 ins. in diameter, reaching from the lowest pit eye to bank. Into these pipes fit the cages, which are mounted on large pistons with leather packing. The cage is raised by exhausting the air at the top of the pipe, and the down trip is accomplished by gravitation, the rate of fall being regulated by throttling the after-flow of air. By this means the ventilation of the mine is effected at the same time. So far, the system has only been tried once, namely, at the Hottingue shaft, near Epinac.

In the Mahnert system two pipes are built in the shaft, these being filled with water, and connected at the bottom by means of a lock chamber. The load is inserted in an iron vessel, which ascends to the surface in the upcast pipe, whilst the emptied and suitably weighted vessels sink down the intake pipe. This method has not been tried in practice.

CHAPTER VI.

HAULAGE IN LEVELS AND INCLINES.

HAULAGE on the level and in inclines is divided into two chief classes:—

I. Stationary motors:—

(*a*) The tub wheels run on permanent tracks.

The motive power is transmitted from the motor to the tubs by means of ropes (rope haulage), or by means of chains (chain haulage).

(*b*) The track for the tubs is a freely suspended wire cable (wire-rope tramways).

II. Locomotive haulage.

I. HAULAGE BY STATIONARY MOTORS.

Rope Haulage.

1. The tubs are attached to the end of the rope:—

(*a*) Incline haulage;

(*b*) Haulage with rope and return rope;

(*c*) Haulage with main and tail rope.

2. The tubs are attached to an endless rope, running above or below them (endless over rope or endless under rope). In either event the rope may be plain or knotted.

Since all these systems have certain points in common, we will first deal with:—

(*a*) The coupling of the tubs to the rope;

(*b*) The method of supporting the rope, and guiding it round curves;

(*c*) The moving of the rope, and then with

(*d*) The methods of haulage.

(*a*) **Coupling.**—The end of the rope is fitted with a hook or an eye-ring, and is attached therewith to the coupling on the tub. The latter should be provided with strong couplings and coupling bars extending right through the frame. The tubs are formed into a train, and the front tub is hooked on to the end of the rope. A more troublesome method, but one more reliable for steep inclines, is to couple about every second or fourth tub direct on to the rope, either by running a bridle chain along under the tubs, or leading the rope itself under them. At suitable intervals the rope is fitted with hooks which engage in eyes on the tub frames. To couple tubs or trains to an endless under rope use is made of clamps, which grip the rope and are connected with the tubs by hooks or bridle chains.

Fig. 89 shows the Neitsche clamp, consisting of a pair of cheeks which are made to grip the rope on being screwed up by a rimless hand wheel. The operation can be rendered automatic either way by the aid of a horizontal ladder, the spokes of which engage with and turn those of the hand wheel. At the pit eye the track is raised, in relation to the rope, whilst at the junctions with the side roads it is lowered, so that in the former case the rope can escape from between the jaws of the clutch, and in the other enters between them. This system is particularly adapted for haulage above-ground, or for trains of tubs accompanied by a conductor. In many instances the grip consists of a pair of tongs (Fig. 90) over which slides a ring. The ring can be pushed up, and the rope released automatically at the pit eye, by means of appropriately bent rails. Fig. 91 illustrates a method wherein the rope is clamped on to small trucks that fit between the axles of the tubs and carry the latter with them. Used in short, straight, steep inclines.

Tubs may be attached to overhead ropes in the same manner as to under ropes. Simple coupling chains are also used, a light chain being fastened to the tub, then twisted two or three times round the rope, and the terminal hook fixed in one of the chain links. This plan is less injurious to the rope than clamps, and there is no difficulty in guiding the rope round curves. On the other hand, the rope is liable to twist on its own axis, especially

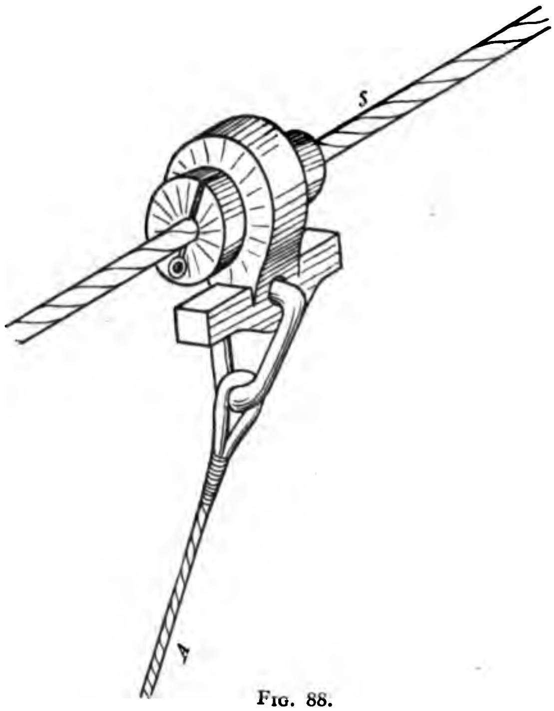


FIG. 88.

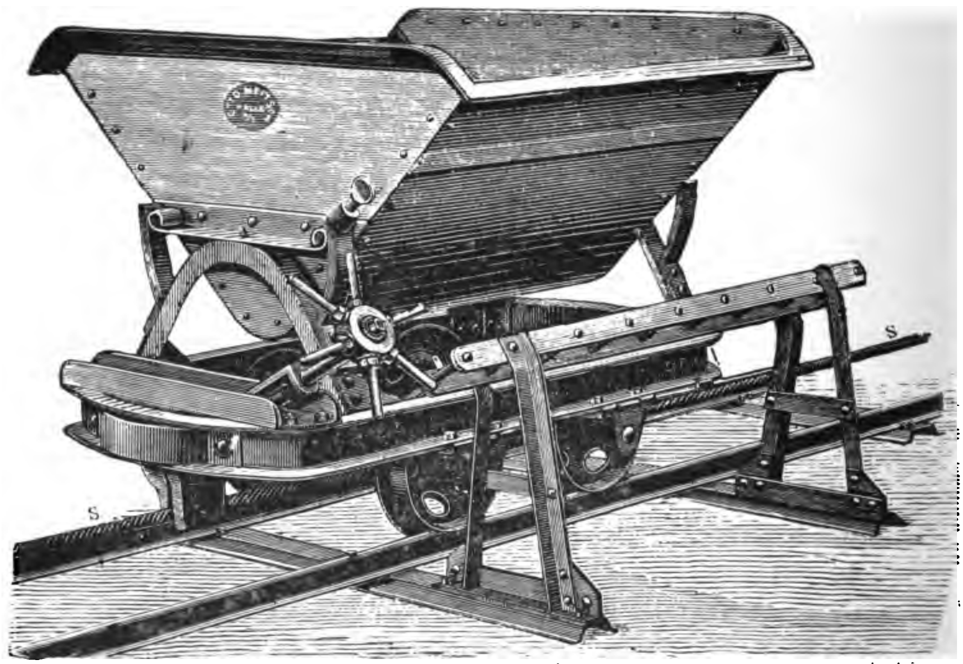


FIG. 89. (*Note.*—S = haulage rope; A = coupling rope.)

when new, under variable tension, or when going round curves, the

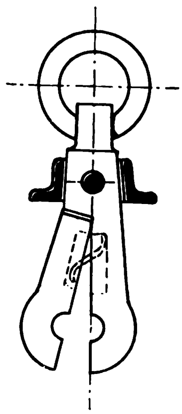


FIG. 90.

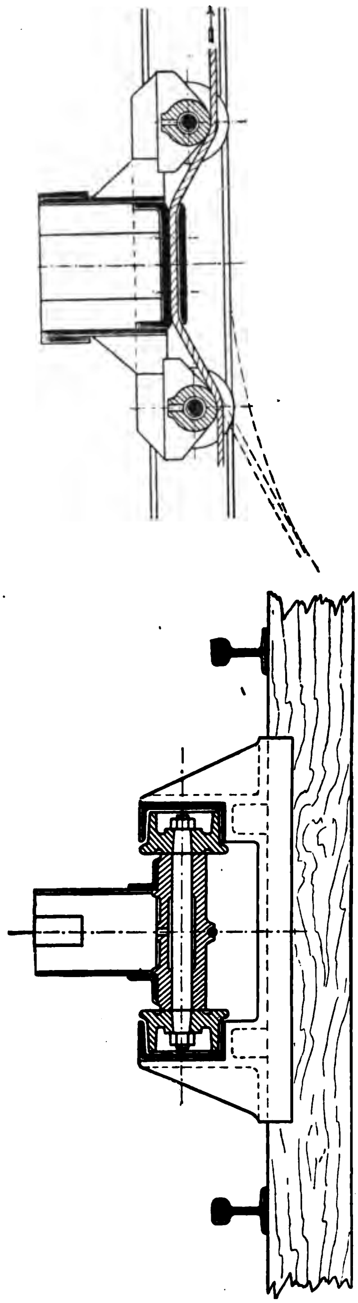


FIG. 91.

result being that the chain gets shortened and draws the tub off the

track. Again, the tubs must be coupled by hand, which entails a greater amount of labour, and the system is no good for work in inclines. Instead of slinging the chain over the rope, use may be made of a clamp (Fig. 92), which is closed by a screw or by the pull on the chain, the ring, R, then serving to secure the fastening. Fig. 88 shows a clutch for train haulage in inclines. Most frequently, however, the coupling between a smooth, overhead rope and the tubs is effected by forked carriers, the English form being shown in

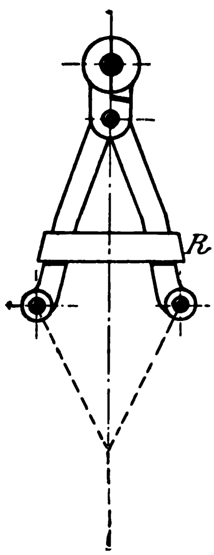


FIG. 92.

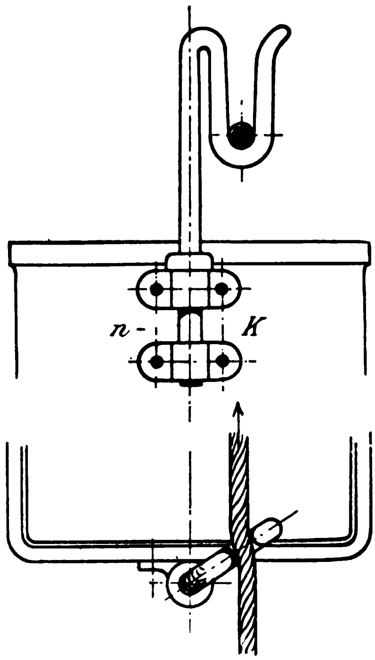


FIG. 93. (*Note.*—K = tub body.)

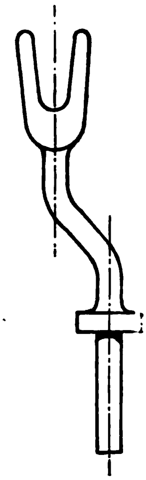


FIG. 94.

Fig. 93, whilst that represented in Fig. 94 is better adapted for counter curves. The eccentric pull of the rope twists the forks round a little, so that a slight kinking of the rope is produced in the slot, and the tub is drawn along. To release the rope automatically from the forks, the former is raised, and a slight downward gradient is given to the track (see Fig. 122), whereby the truck runs downhill of itself, whilst the fork withdraws and leaves the rope free. When the forks are much worn or damaged, and therefore turn with difficulty, they are often lifted away from the

tub, and on this account a detacher is placed in front of the rope pulley to throw off the forks. Again, the tubs may easily get jammed and derailed if the rope is not lifted out of the forks in good time, and the latter do not turn easily in their sockets. These inconveniences in the automatic release form the chief disadvantage

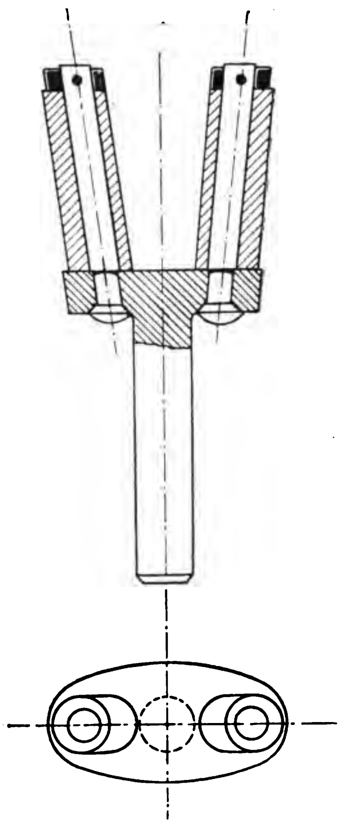


FIG. 95.

of the English rope forks, which otherwise, from their simplicity, are among the best of their kind.

Brown's fork, in which the clamping of the rope is accomplished by means of eccentric sleeves, is illustrated in Fig. 95.

The carriers to be mentioned later, in connection with wire-rope tramways, are also suitable, in principle, for smooth, overhead ropes, but it is not advisable to fit such expensive and easily

damaged couplings to tubs that are exposed to the rough usage of the pit.

The endeavour to discover some method of coupling tubs to the rope, at once simple, cheap, suitable for travelling round curves and up and down inclines, and at the same time automatically detachable and protecting the rope, has led to the employment of knotted ropes, the advantages of which, however, are almost entirely nullified by their numerous inherent defects.

Fig. 96 shows a rope provided with a knot, K, and a counter knot, K', for use in double gradients. The fork in this case is centric. The simplest knots—which, however, are exposed to the greatest wear, and consequently must most often be renewed—

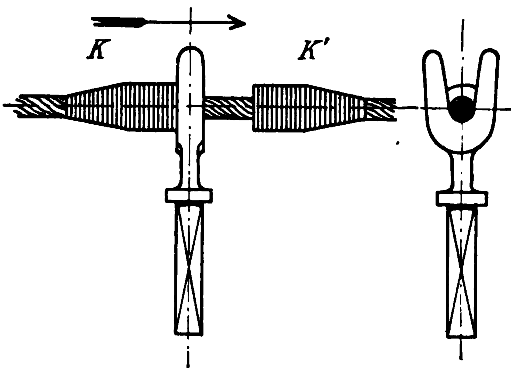


FIG. 96.

consist of well-tarred hemp and hempen cord. Sometimes the end nearest the fork is capped with steel, or the knots are made of divided steel sleeves.

Improvements—though at the expense of simplicity—have been made in knots, by fitting them with elastic coverings or enclosing them in front and rear, so as to do away with the counter knots.

Whereas with the English fork the points of attachment to the rope are constantly changing, and the wear on the rope is consequently uniform, the wear on knotted ropes is always in the same spots. This may be avoided by frequently changing the position of the knots, but the remedy is an expensive one.

(*b*) **Rope Guides.**—1. *For Open Rope or Under Rope.*—To diminish the wear and resistance, the rope must be prevented from

dragging on the floor of the haulage road, and to this end flanged rollers, 6-10 ins. in diameter and about 6-12 ins. broad, must be arranged at distances of 4-8 yds., according to the minimum rope tension and the height of the rollers above the sleepers. These rollers are of cast-iron, or wood with iron hubs, and run on well-greased fixed journals. They must be well mounted, and looked after with care, or they will soon begin to run so stiffly that the rope commences to slip over them.

The rope may be guided round curves :—

(*a*) By alternately vertical and horizontal rollers (Fig. 97), the former being often slightly taper, with the greatest diameter overhead, to prevent the rope mounting upwards.

(*b*) By slanting rollers, fitted with high flanges (Figs. 98, 99).

Since, with these rollers, the rope is not entirely prevented from springing out, bobbins, W, are provided at intervals, to catch the rope in this eventuality. The rollers are not mounted in the centre of the track, but somewhat nearer the centre of curvature. In very sharp curves they must even be placed outside the track, when the tail rope can be induced to enter properly.

2. *For Overhead Ropes.*—On straight roads the rope lies in the forks and is supported thereby, rollers being only needed in the curves and at junctions where the rope is lifted; though if the intervals between successive trucks are considerable, some means must be provided for keeping the rope from dragging on the floor. In curves, the rope may either be left attached to the tubs, or the latter may be freed and left to run of themselves down the gradient then provided for this purpose, to be coupled up again when they re-enter the straight.

This latter method involves considerable labour, and is therefore seldom used. The curve rollers are made as large as possible, and distributed in such a manner that the divergence of the rope by any single roller does not exceed about 12°. The usual form is shown in Fig. 100. To ensure the rope re-entering the forks, it is a frequent practice to provide swing rollers that fit under the rope and are pushed aside by the passing forks. According to Forster, sharp curves should contain only a single large guide pulley (Fig.

101), the rails being replaced by U-irons or by a flooring of iron plates.

(*c*) **Methods of Actuating the Rope.**—The rope is either wound round an ordinary drum, or led over driving pulleys, being drawn onward by the friction between the rope and the pulley grooves.

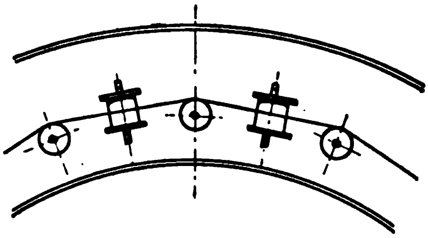


FIG. 97.

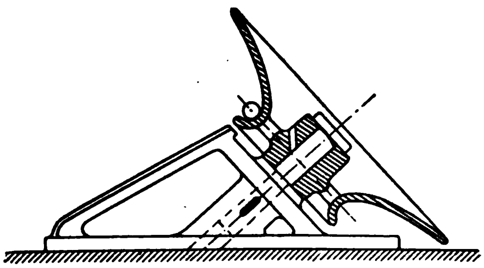


FIG. 98.

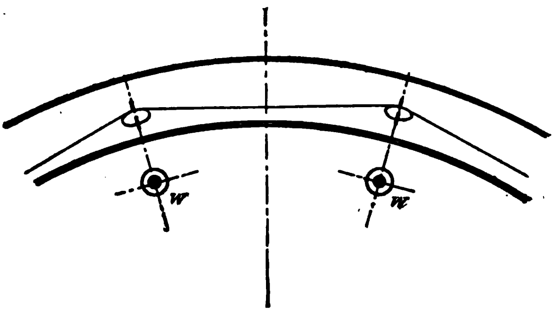
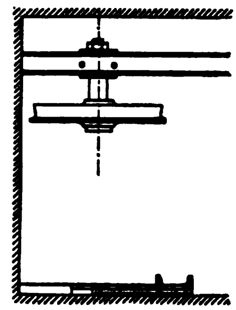


FIG. 99.

In order to preclude slipping $\frac{S}{S_1}$ must be $< e^{fa}$ (see p. 68), S being the tension of the oncoming rope, S_1 that of the paid out tail rope, e the base of the natural log, a the embraced arc, and f the co-efficient of friction (for ropes running on cast-iron, $f = 0{\cdot}1$; on wood, $f = 0{\cdot}2$).

Unless this condition be fulfilled, the embraced arc of the pulley must be increased, or the friction augmented, or the ratio $S \div S_1$ diminished, by increasing the tension on both ends of the rope by an equal extent.

1. *Increasing a.*—The rope is wound several times round the pulley. In Fig. 102, for instance, $a = 3\pi$. In such case the on-



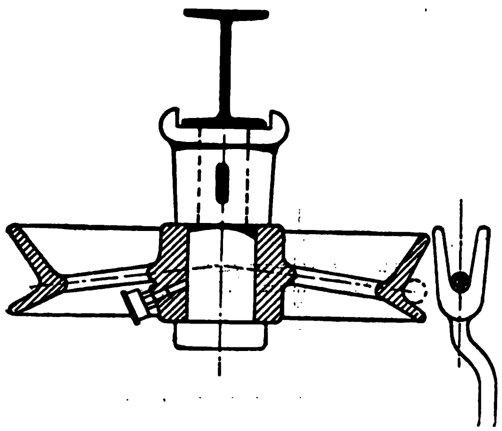


FIG. 100.

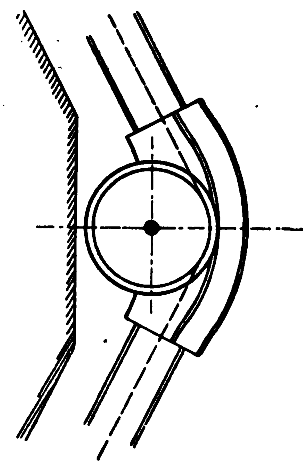


FIG. 101.

coming rope has to constantly push aside the turns already on the pulley, the wear being thereby augmented. Mounting the pulley in the manner shown in Fig. 102, or providing a sickle-shaped guide bar, S, will facilitate the coiling of the rope; but the continued sliding of the rope is injurious.

Another arrangement is shown in Fig. 103. Here T is the

actual driving pulley, L merely a guide pulley, the serial numbers indicating the path taken by the rope. If, for example, T is provided with four grooves, then a three-grooved guide pulley will be required. A better plan is to have three single-groove guide pulleys, only one of which is mounted fast on its axis, whilst the other two

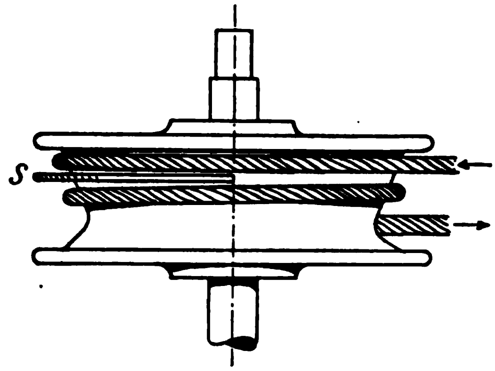


FIG. 102.

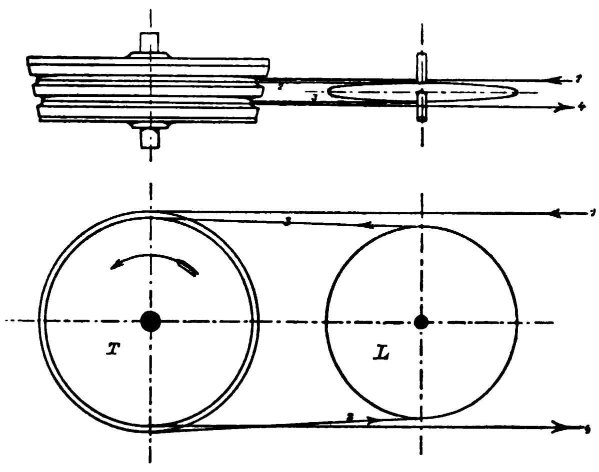


FIG. 103.

run loose, so as to take up slight fluctuations of the rope, without slipping. Very often the one guide pulley runs on a fixed axis, whilst the two loose pulleys are mounted on extensions of the hub, because the relative displacement of the pulleys in revolving is but small, and hence the wear of the hubs is prevented and the simplest lubrication is sufficient.

Owing to the fact that the intake groove of the driving pulley is exposed to the greatest amount of wear, the grooves are made of slightly decreasing diameter, as shown in the drawing.

Laying the rope in S-curves on the pulleys, in order to increase the embraced arc, increases the wear on the rope, and should be discarded.

The driving and guide pulleys should be well stayed one against the other.

2. *Increasing the Friction.*—The coefficient of friction can be raised to 0·2-0·3 by lining the grooves of the rope pulley with wood or leather (Fig. 104). Sometimes hempen rope is laid in the

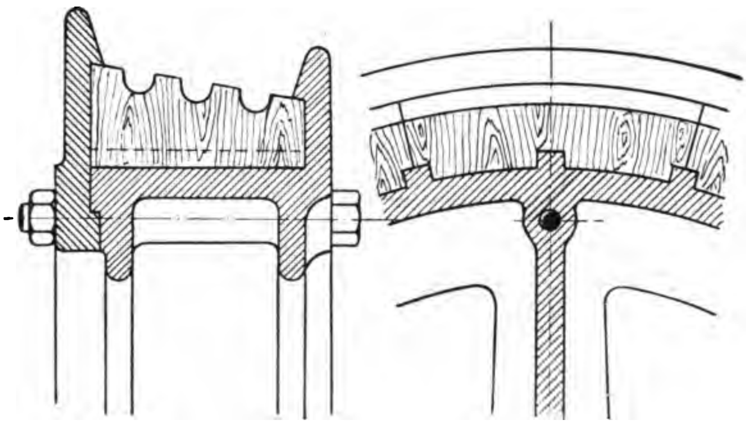


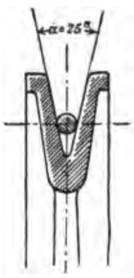
FIG. 104.

grooves. All these means protect the rope, but need frequent renewal of the material.

The friction may also be augmented by increasing the normal pressure, the cross-section of the groove being given the form shown in Fig. 105. Here, as before, $S = S_1 e^{fa}$, though the value 0·26 can be substituted in place of 0·1 for f. The wear on the rope is considerable. Fowler's pulley, which belongs to this class, is but little used in mining work.

3. The value of the expression $S + S_1$ may also be diminished by increasing both tensions, for $\frac{S + q}{S_1 + q}$ approximates more closely to unity the higher the value of q. With open ropes—tubs at the

extremity of the rope—the dead weight of the rolling stock is increased for this purpose; but for endless ropes tension appliances are provided. In both instances, however, the rope tension is augmented, and therefore also the rope diameter, waste of power, etc.



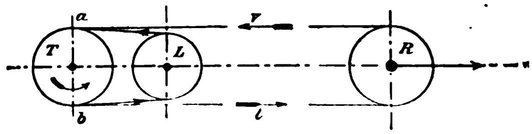


FIG. 106.

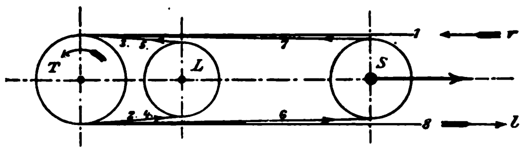


FIG. 105. FIG. 107. (*Note.*—v = loaded; l = empty.)

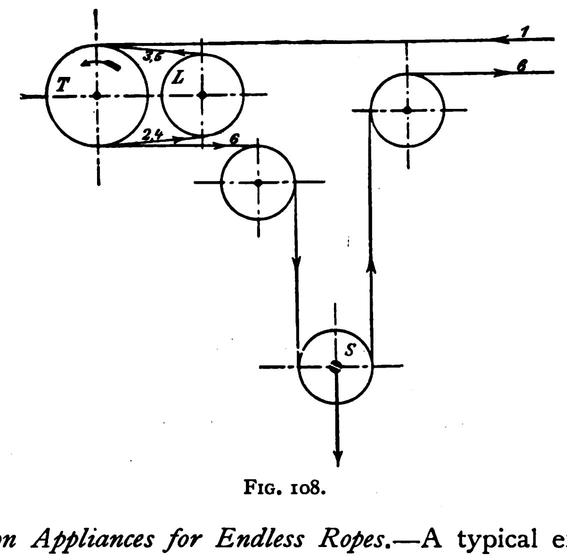


FIG. 108.

Tension Appliances for Endless Ropes.—A typical example of the course taken by the rope is shown in Fig. 106, T being the driving pulley, L the guide pulley, and R the end pulley for the return of the rope. The tension differs in all positions, being greatest at a and smallest at b; but even in the latter position must be great enough to prevent the rope hanging too slack, dragging on the floor, or slipping over the driving pulley. The adjustment of this

tension, and keeping it up should the rope stretch, is the task of the tension appliance. For this purpose L or R, or both of them, are mounted in such a manner that they may be moved in the direction

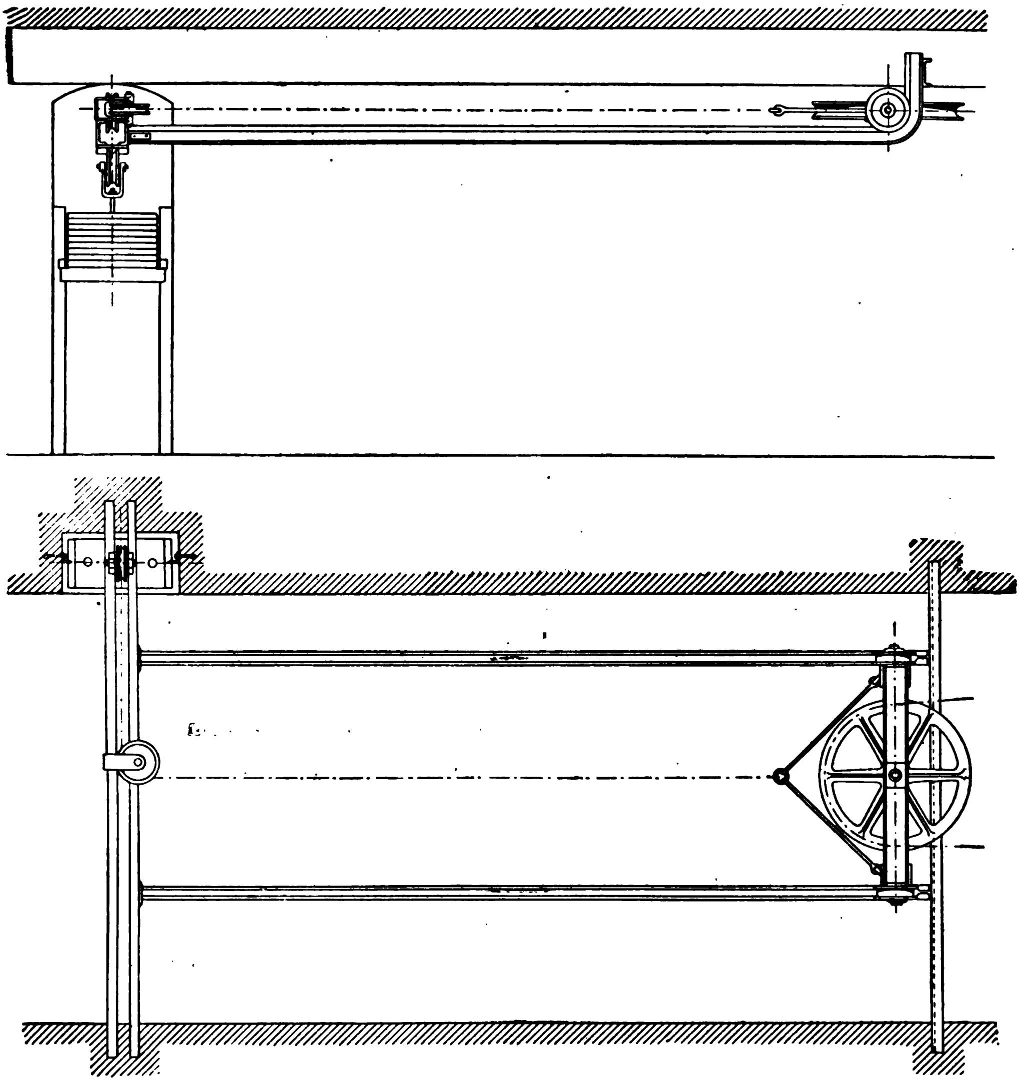


FIG. 109.

indicated by the arrow. The adjustment of the guide pulley is mostly effected by the pull of a weight, and therefore automatically, in which event it serves to maintain the tension, whilst the stretch

of the rope is taken up by moving and refixing R by hand when necessary. In multiple-groove guide pulleys, L, this method cannot be adopted, and a separate tension pulley must, therefore, be provided near the driving pulley.

Fig. 107 applies in the case of vertical driving pulleys, Fig. 108 for those mounted horizontally, Fig. 109 shows an automatic tension pulley (Hoppe's). Instead of weights, the chain for adjusting the tension pulley may be acted on by a screw spindle. When the rope stretches considerably the chain is shortened.

(*d*) **Systems of Haulage.**—1. *Uphill Double-track Haulage in Straight Roads. Haulage in Inclines.*—The tubs—or skeleton trucks in steep inclines—are fastened to the tail of the rope, and are hauled by a winch fitted with drums or pulleys. If conical drums are used, care must be taken that the tubs do not meet in the middle of the road. Rope pulleys are specially adapted for haulage on skeleton trucks. The calculations for the motors and brakes are identical with those for winding engines. The resistance is compounded of the relative weight of tubs and rope, friction in the tubs (about 2 per cent. of the normal pressure), and the guide-pulley resistance, which for initial calculations may be ascertained by adding to the weight of the tubs 17 to 25 lb. for every 100 yards of track.

If the gradient of the track is progressively steeper from below upwards, the relative weight of the ascending tubs increases, since the length of rope is a continually diminishing quantity; the converse applies to the descending tubs, so that by altering the gradients the weight of the rope can be compensated. The calculation gives a cycloid as the profile of the track.

With varying gradients the engine-power has to be determined for different parts of the track, and the maxima thus obtained must be borne in mind.

The mean velocity is v = 80 ins., the maximum under favourable conditions being twice as great, or even more.

Track.—(*a*) Double track throughout. This is the best, but most expensive method.

(*b*) (See Fig. 110.) Single track with sidings at intervals, and

movable points. The tubs or trains pass each other at *m*, *n*. The descending tub, A, is switched automatically by the points, which are then in position for the ascending tub, B, which in turn displaces them in the opposite direction.

This method is cheaper as regards construction of track and road, but is attended with the defects of the points.

(*c*) Movable points at *a* and *b* (see Fig. 111). The descending tubs must pass over the up-going rope at the switch, and *vice versâ.* It is difficult to dispense with the employment of a watcher at the points, and hence the lower cost of installation is counterbalanced.

A very good plan is the one shown in Fig. 112. Both the

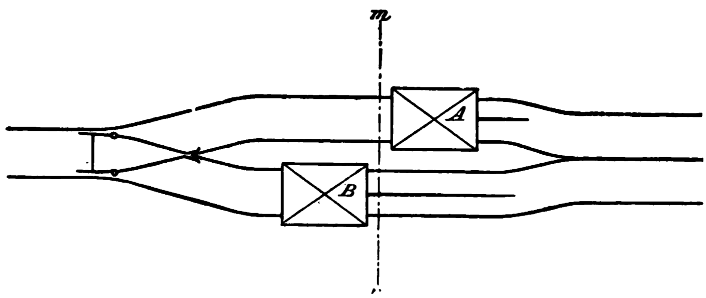


FIG. 110.

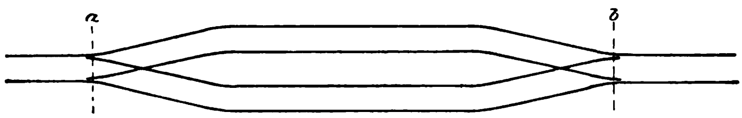


FIG. 111.

skeleton trucks have very broad smooth inside wheels, the outer ones being fitted with double flanges. The rope is guided so as to lie between the rails at A and B, whilst the second truck passes over it. In the upper half of the road the rope is guided on two sets of rollers, one for the up and the other for the down rope.

Setting-on Places.—For single tubs or short trains a flooring of iron-plates is best. Long trains require crossings and switches, the rope running under the track floor towards the engine. For skeleton trucks and double tracks, either small draw-bridges must be provided, to enable the tub from the one truck to be pushed over the lower track of the other, or else the tracks are run together at

the top, as in Fig. 113. The tubs are taken from or delivered to the track, *m* or *n*. The truck journeying on A enters at *a* and

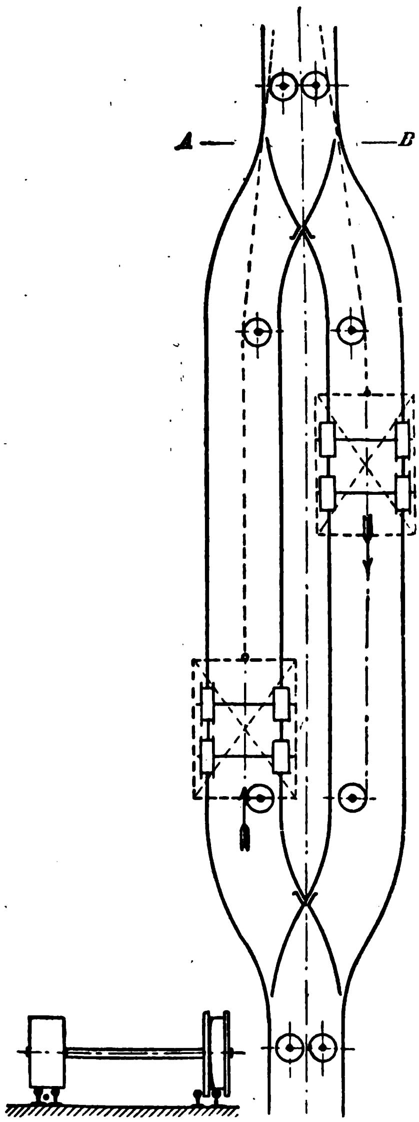


FIG. 112.

must then be displaced further towards *n*, to enable a better connection to be effected with the corresponding track. The same applies to the other trucks, according to their direction.

2. *Haulage with Main and Tail Rope, or with Rope and Counter-rope.*—Single haulage for horizontal roads or slight gradients with few curves.

Fig. 114. The main rope, *v*, extends from the drum, T, to the train of tubs. From the rear of the train the tail rope, *h*, passes

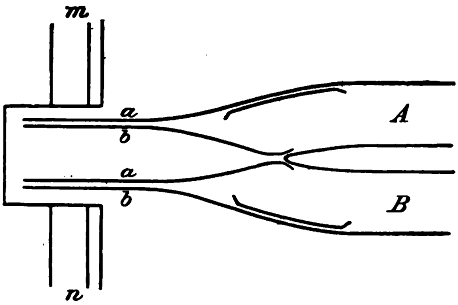


FIG. 113.

over the end pulley, S, back to the second drum, T_1. Each drum can be coupled to, or detached from, the engine in turn. When T is coupled up, the main rope pulls the full tubs in the direction of the arrow, and the tail rope is paid out by the loose pulley, T_1,

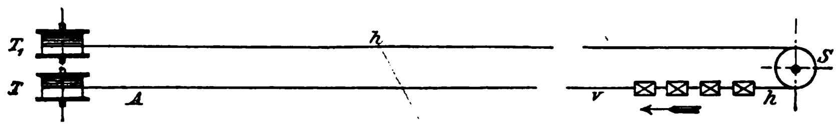


FIG. 114.

which is slightly braked. Arriving at A, the train is unhooked from both ropes, which are then attached to the waiting train of empties, whereupon T is disconnected and T_1 coupled to the engine. The tail rope, *h*, now draws the train, whilst the main rope runs off

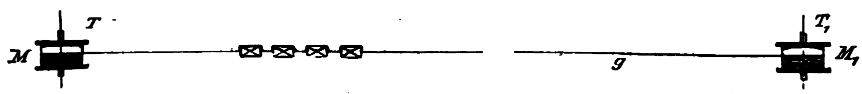


FIG. 115.

from the loose drum, T, and so forth. The tail rope may be guided near the track, against the walls or roof, or even traverse a separate road.

Fig. 115. The drum, T, of the engine, M, pulls the full train by means of the rope, *s*, the counter-rope, *g*, running off from the

loosened (and braked) drum, T_1, of engine, M_1. When the train reaches the pit eye, both ropes are attached to the waiting train of empties, T_1 is coupled up, and the engine, M_1, started whilst T is uncoupled from its engine, M.

Neither of these systems is much in use; that with rope and counter-rope especially, since, although the guiding of the rope is simpler, and the rope resistance lower, than with main and tail ropes, it entails the employment of two engines with their drivers, and some means of signalling from one to the other. Haulage from branch roads is also a troublesome matter with this system.

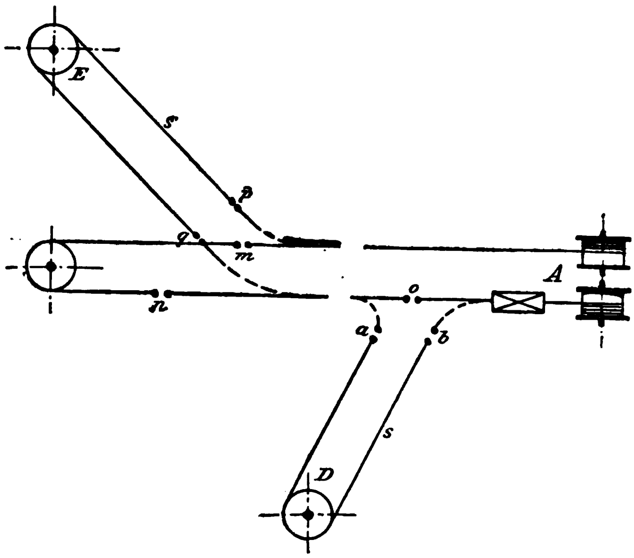


FIG. 116.

The velocity is from 4 to 6 yds., and hence the tracks must be well laid. From 40 to 100 tubs go to a train. Frequently a guard's truck is provided at the end of the train, the guard seeing that the tail rope lies properly on the rollers, especially in curves. He is also able to uncouple the tail or counter-rope quickly.

Hauling from Branch Roads (Fig. 116).—The main rope is divided at *o*, the ends, *a* and *b*, being hooked on to the rope, *s*, in the branch road; or the same procedure is adopted at *m* with regard to the branch rope, *s′*. In either event, the train of empties can be hauled into the branch, without further delay, and the full train

standing at D or E drawn towards A. A rope coupling for this purpose is shown in Fig. 117; but the length of the lashings impedes its passage over the rollers, shorter couplings, such as that in Fig. 117*a*, being preferable.

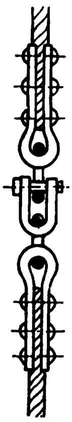


FIG. 117.

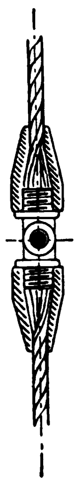


FIG. 117*a*.

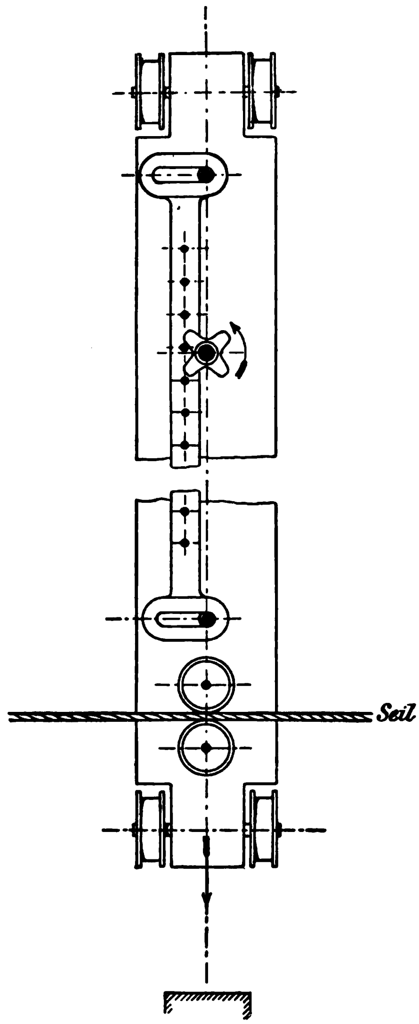


FIG. 118. (*Note*.—Seil = rope.)

Engines.—Single- or double-cylinder engines, driven by steam, compressed air, or water power; electro-motors, etc. Reversing gear, though not essential, is desirable. The drums are mounted on separate shafts, are fitted with brakes, and can be coupled up

or freed by sliding cog wheels or other clutches. The drums, though of small diameter, must be able to take up a great length of rope, and are therefore made broad and provided with attachments for ensuring the proper laying of the superimposed coils of

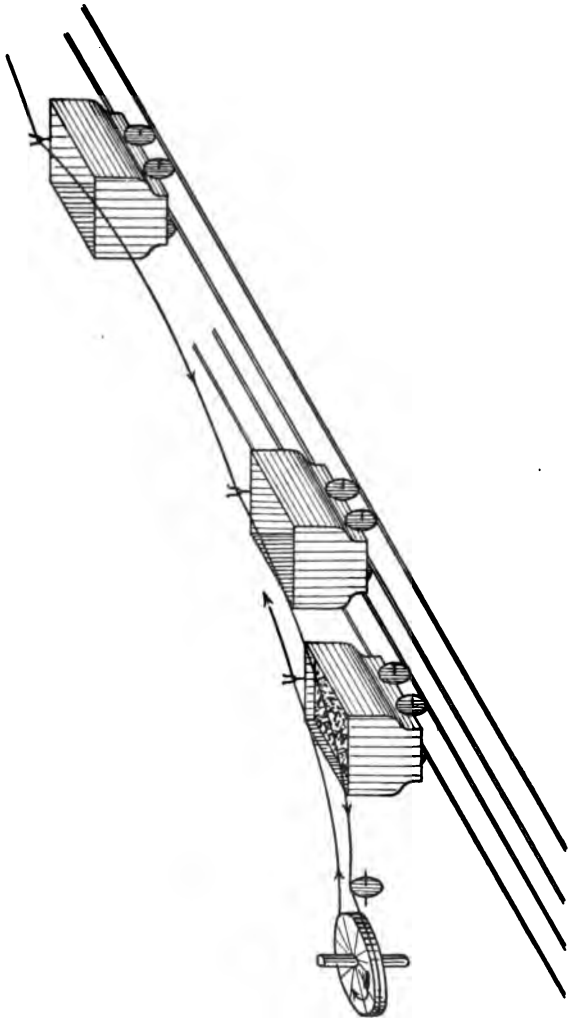


Fig. 119.

rope. These guides consist of slides or small travellers, moving to and fro over the drum and guiding the rope. They are driven in the same manner as the tables on planing machines, or as shown in Fig. 118, the traveller being attached to a vertical shaft driven by the engine. When the guide reaches the end of its travel,

further progress is prevented by an elastic abutment, whilst the traveller forces to the right an adjustable lateral driving bar and then retraces its course.

3. *Endless Overhead Rope* (Fig. 119).—For long horizontal or gently sloping roads with fairly constant gradients. A double track is used and tubs are hauled both ways. The average rate of speed is 40 ins. The interval between the single tubs should be such (15-20 yds.) as to prevent the rope dragging on the floor. The carriers, rope guides and driving gear are the same as those already described.

The direction of movement being constant, no reversing gear is needed, but is desirable in view of accidents. The setting-on places are simple, and the uniform conveyance of single tubs is better adapted to colliery work and cage winding than long trains, which entail an accumulation of tubs at the ends of the roads, and greater danger of derailing. The less powerful engine, running continuously, works more economically and pays for itself off more quickly than the larger engines working under irregular loads in train haulage.

The setting-on places are horizontal or with a gentle slope so that the tubs run down automatically. To facilitate keeping the tubs equidistant, a signal—paint mark, lamp or bell—is set up a certain distance from the setting-on place, and as soon as the last tub has passed this spot, a fresh one can be released, empty tubs being sent on when full ones are lacking. Where tubs are to be set on at intermediate spots, the rope must be raised there by means of rollers to enable this to be done.

Hauling from Branch Roads.—The usual system is shown in Fig. 120. A is the chief motor, and at B three pulleys are mounted on the same upright shaft, for the three endless ropes, 1, 2 and 3. C and D are the end pulleys. If the pulleys for 2 and 3 are mounted loose, and fitted with detachable couplings, the work can be stopped in either of the branches, as required. If local circumstances permit, it is preferable to have the chief motor set up at B.

4. *Endless Under Rope.*—This system is employed where the traffic is slack, and the tubs are at irregular distances, so that an

overhead rope would drag on the floor; it is also useful in roads of variable gradient and curvings. Above-ground it is employed for steep inclines, though in similar cases in the pit winch hoists are preferable.

Single tubs or short trains may be hauled; in the latter event, only three or even two rails are required. The friction and wear of the rope are greater than with overhead ropes.

Chain Haulage.

1. **Overhead Chain.**—Arrangement same as in Fig. 119, but with a chain instead of a rope. Equal or even superior to rope haulage for straight roads with numerous setting-on places, alternat-

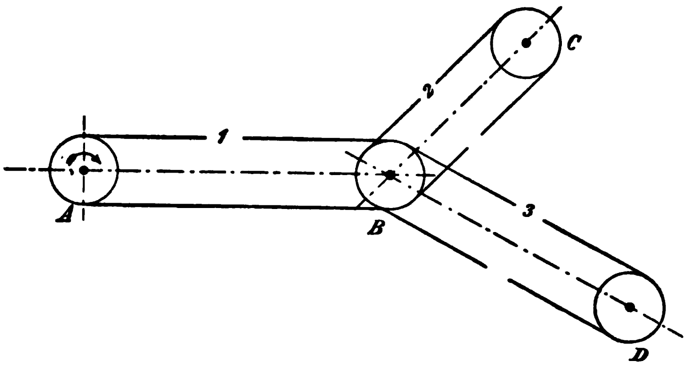


FIG. 120.

ing gradients, and especially hollows. The speed is 40-80 ins., being higher than with ropes, the heavy chain resting on the tubs, increasing their stability and thus lessening the risk of derailing. The higher speed enables an equal amount of haulage to be done with a smaller number of tubs on the line at any one time. The chain costs about three times, and weighs about five to six times as much as a corresponding rope, the greater weight increasing the tub friction and the motive-power required. Chains break suddenly without any previous warning, whereas the damaged portions of ropes are revealed, by projecting ends of wire, long before the rope parts. On the other hand, the broken links of a chain can be quickly replaced by temporary substitutes, whilst the splicing of

ropes entails a prolonged stoppage. True, the substituted links form a source of weakness, and cannot always be replaced by new welded links underground. The life of a chain is two to four times that of a rope.

Coupling the Tubs.—The chain rests free on the tub top (without

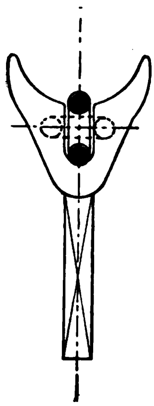


FIG. 121.

carriers), and exerts its tractive force by the friction of the links on the upper frame and contents of the tub. For steep ascents, and in travelling round curves unprovided with guides, chain forks (Fig. 121) are fastened to the front ends of the tubs.

Method of Driving.—The chain is passed ½ or

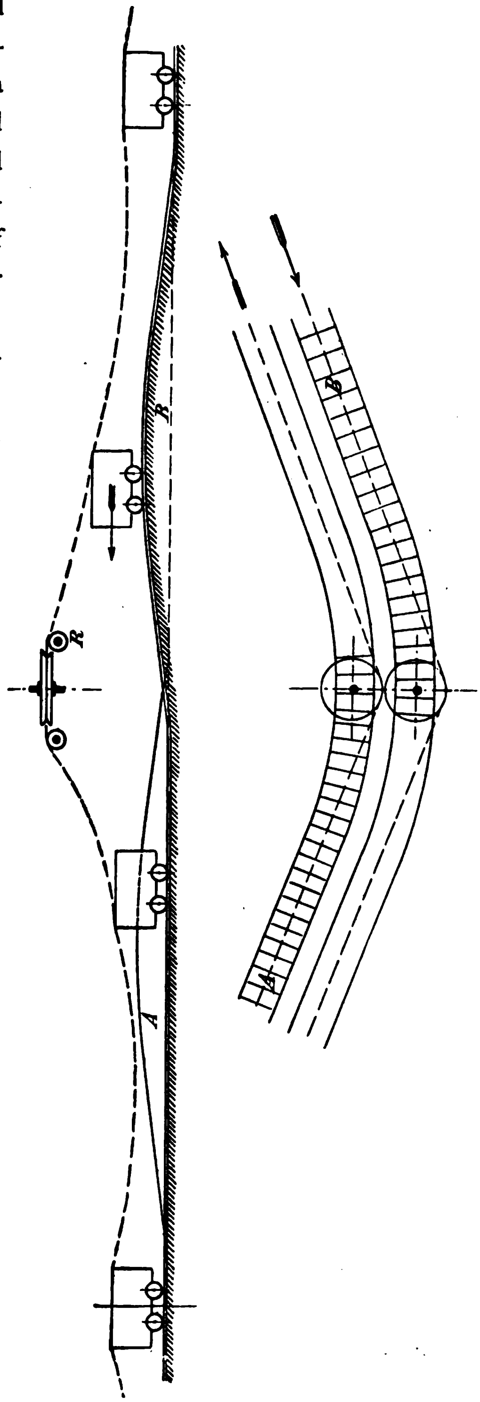


FIG. 122.

$1\frac{1}{2}$ turns round a pulley, with a smooth or wood-lined groove, of slightly conical section to facilitate the displacement of the preceding coil by the on-coming chain. Sickle-shaped guides are provided

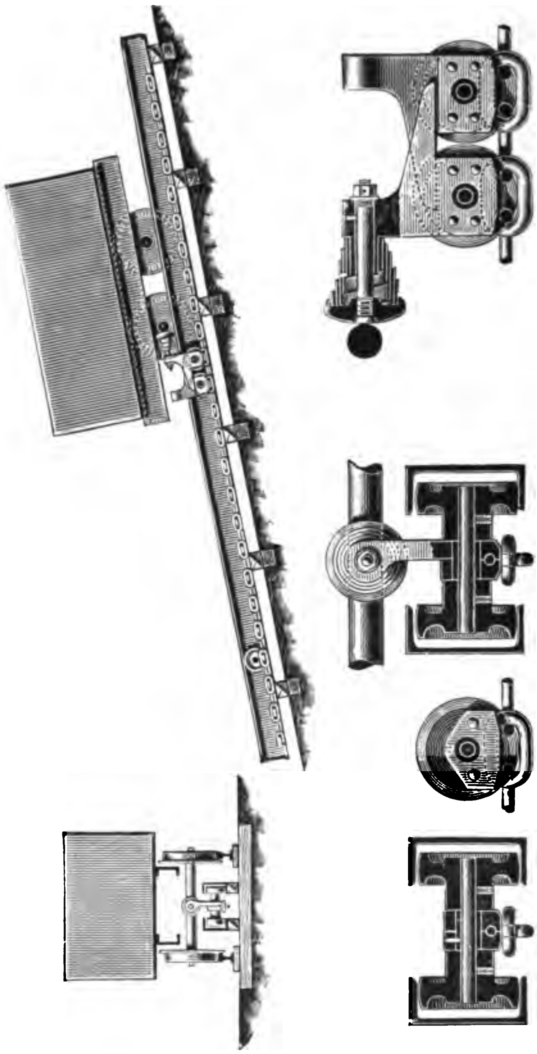


FIG. 123.

for the same purpose. Chain-peg (sprocket) rollers require calibrated chains, and fail to act if the chain stretches and wears unequally. Where the tractive force has to be high, the best plan is to employ a driving pulley and counter-pulley, as in the case of ropes. The

setting-on places and hauling from branch ropes are the same as described under " Rope Haulage".

Passing Round Curves.—As shown in Fig. 122 the chain is led over high-mounted pulleys, and the track is graded downhill so that the released tubs may run through the curve of themselves until caught again by the lowered chain. Another method of traversing curves has been described on p. 99.

2. **Under Chain.**—This method is specially adapted for short, steep inclines.

Fig. 123 illustrates the Humboldt system. A pair of channel irons, mounted between the rails, forms the track for the carrier trucks, which are fastened to the chain and press, by means of a small buffer, against the axle of the tub, which therefore does not require any special fittings.

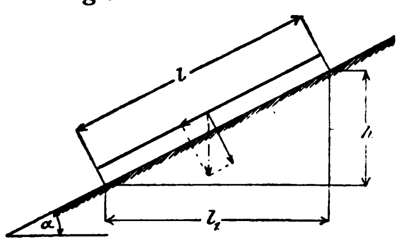


FIG. 124.

The carriers are made of such a shape that they can pass over the chain pulleys.

Calculations for Rope and Chain Haulage Tracks (Fig. 124).—The organ of traction and the tubs may be regarded as a load uniformly distributed over the track. If g represents the weight of rope or chain per unit length (running yard), a the distance between the tubs, and P the weight of the latter (P for full tubs, and P_v for empties), then the load aforesaid will be $g + \frac{P}{a}$ per running yard of track. The weight for the whole track, l, will amount to $\left(g + \frac{P}{a}\right) l$; and to draw this weight uphill a force Z will be required, the amount of which is compounded of the relative gravity

$$\left(g + \frac{P}{a}\right) l \times \sin \alpha = \left(g + \frac{P}{a}\right) h$$

and the friction

$$\mu\left(g + \frac{P}{a}\right) l \times \cos a = \mu\left(g + \frac{P}{a}\right) l_1.$$

Hence, $Z = \left(g + \frac{P}{a}\right) (h + \mu \times l_1)$, wherein h is positive for uphill gradients and negative for descending tubs, l_1 being positive when the motion is towards the source of power, and negative in the opposite direction. The total coefficient of friction, μ, may be taken as 0·01 under favourable circumstances, and 0·02 for bad or greatly curved tracks.

The completed equation enables the rope pull to be determined for any part of the track.

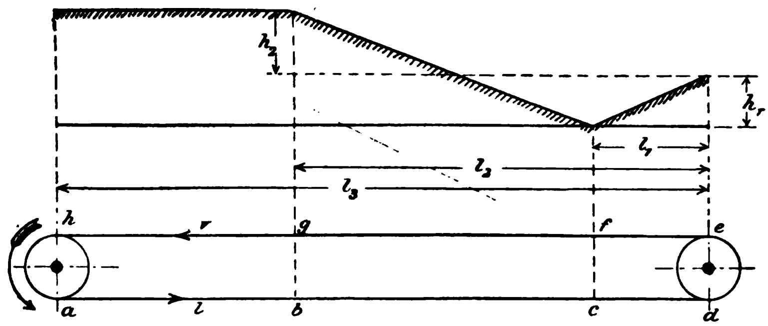


FIG. 124*a*. (*Note.*—v = full; l = empty.)

If the installation be represented by Fig. 124*a*, and the still unknown tension in e by S (for the present), it will be

$$\text{at the point } f = S + Z = S + \left(\frac{P_v}{a} + g\right) (-h_1 + \mu l_1),$$

$$\text{,, ,, } g = S + \left(\frac{P_v}{a} + g\right) (h_2 + \mu l_2),$$

$$\text{,, ,, } h = S + \left(\frac{P_v}{a} + g\right) (h_2 + \mu l_3),$$

and for the return track (empties)

$$\text{in } c = S + \left(\frac{P_e}{a} + g\right) (-h_1 - \mu l_1),$$

$$\text{,, } b = S + \left(\frac{P_e}{a} + g\right) (h_2 - \mu l_2),$$

$$\text{,, } a = S + \left(\frac{P_e}{a} + g\right) (h_2 - \mu l_3).$$

Of these strains that at f will presumably have the lowest value ;

but even here it should not fall so low as to allow the chain or rope to drag on the floor. For ropes a "dead" tension, S_0, of 4-6 cwt. will be sufficient; for chains it should be about equal to the weight of 50-60 yds. of chain. By setting down the tension in $f = S_0$, *i.e.*,

$$S_0 = S + \left(\frac{P_v}{a} + g\right) \ (-h_1 + \mu l_1),$$

and estimating g approximately for the present, we obtain the value of S, whence the value of the maximum tension (S_{max}) in h can be determined. This amount is increased by the friction of the rollers. In preliminary calculations it is sufficient to allow for this factor an extra 5-15 per cent., according to the number of curves in the road. For exact calculations the pull required to move a roller of radius R may be assumed as $0{\cdot}1 \times K \times \frac{r}{R}$, wherein K implies the normal pressure on journals of radius r. In the case of driving and guide pulleys, R is the resultant of the rope tension; for carrier rollers the weight of the superincumbent portion must be substituted. A small extra allowance must be made for the resistance of the chain or rope to flexion. From the useful tension S_n—difference between the maximum and minimum pull of the rope—is found the engine-power required, for a haulage speed $= v$ and efficiency η, by the formula $N = \frac{S_n \times v}{\eta \times 75}$. The engine must, however, be capable of exerting a momentary force, at least $1\frac{1}{2}$ times this, for starting, etc.

The tensions in a and b being known, the requisite number of turns to give the rope on the driving pulley can be ascertained. The strength of rope or chain is selected in accordance with S_{max}.

If the full tubs run from a higher to a much lower plane, the engine is replaced by a brake.

Traversing Hollows.—Fig. 125 shows that, in hollows, the rope is raised out of the forks in the event of x being less than b, x itself being calculated from the equation of the arc described by the hanging rope, and taken as $x = \frac{(2a)^2 \times g}{8 S}$, wherein g is the weight of the rope, or chain, per running yard, and S the tension at this

portion of the track. To ensure safety x may be required to be $1\frac{1}{2}$-2 times greater than b; and if this be impracticable, the curve of the rope must be increased by artificial means.

According to Fig. 125*a* a number of heavy rollers are laid on the rope, which must be eased a little from the tubs every time, by the

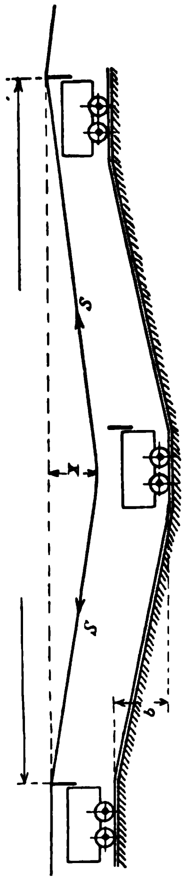


Fig. 125.

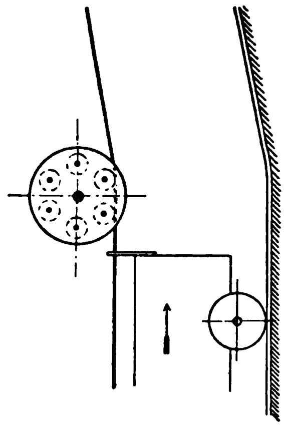


Fig. 125*b*.

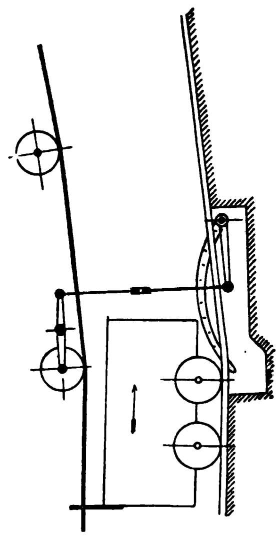


Fig. 125*a*.

aid of a suitable lever, in order to ensure the passage of the carrier; or Forster rollers (Fig. 125*b*) may be used. These consist of two side shields with small interposed rollers, against which the carrier strikes, turns the pulley round a little, and then proceeds on its way.

Traversing Curves without Guides.—By raising the inner rail the tubs are tilted outwards, tipping over being prevented by the resultant of the rope pull in the direction of the centre of curvature. This mean force, M, must be determined, and then a calculation made to ascertain whether the (empty) tubs still possess sufficient stability. Curves with a radius exceeding about 160 yds. can be safely traversed in this manner.

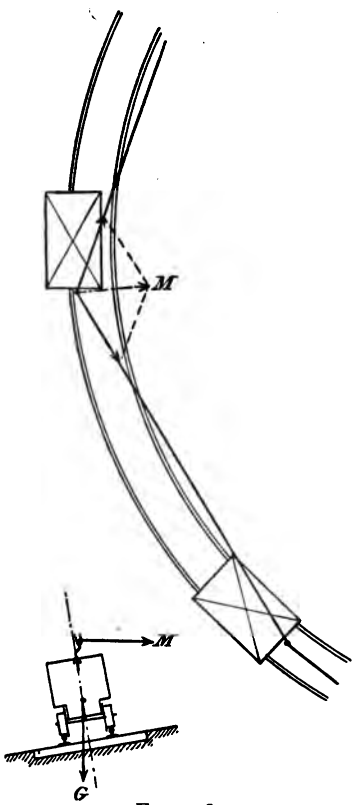


FIG. 126.

Wire-rope Tramways.

The track consists of two parallel wire ropes — line ropes — firmly anchored at one end, kept taut by weights at the other, and supported at intervals by a row of wooden or iron frames or pillars. The travellers of the skips run on the line rope, and the traction is effected by an endless draught rope.

Details.—The line ropes are of circular section and made of thick wires, patent locked ropes being also used of late. The diameter of the rope varies according to the strain, 0·8-1·6 ins. being the usual limits for the one supporting the full skips, and 0·6-1·2 ins. for the return line (empties). The various lengths of rope are connected by coupling sleeves. The usual arrangement in the Pohlig simplex rope is shown in Fig. 127, the rope ends, which are widened by means of conical wedges and covered with composition, being tightly encased by steel sleeves which are screwed together by means of a pin.

The line rope should be supported every 50-60 yds., but in crossing rivers or valleys the span may measure as much as 500 yds. The supports consist of pillars or lattice derricks surmounted by

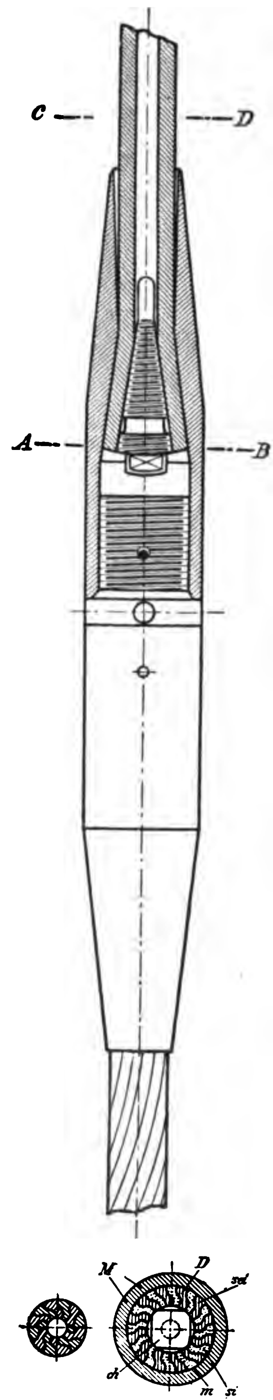


FIG. 127. (*Note.*—M = sleeve; D = wire of rope; *ch* = conical screw wedge.)

carrier rollers, or by grooved iron shoes into which the rope fits without any fastening. To rapidly and effectually compensate differences in tension, and in fact impart the requisite tension to the rope as a whole, the one end is anchored, whilst the other is connected to a chain which is led over rollers and carries a heavily weighted chest. By this means a rope tramway of over 1,000 yds. in length may be kept in tension; but for greater distances intermediate tension appliances are necessary. The form of the skips is shown in Fig. 128, consisting of a traveller, a supporting stirrup, with clutch, and the skip proper—generally arranged to tip. The load carried ranges from four to fourteen cwt.

The clutch, connecting the skip with the draught rope, is a particularly important appliance, being the factor deciding the life of the rope and the simplicity and security of the haulage. For slight gradients (1 : 7) eccentric clamping blocks, which are closed by the pull on the rope, so that the pressure is automatically adjusted to the gradient, are sufficient. A better grip is afforded by plates, pressed against the rope by means of screws. In the new Pohlig clutch (Fig. 129) the screw spindle in the one block has a very quick right-hand thread, that in the other having a very slow left-hand thread, the former serving for rapid coupling and detaching, whilst the other is used for applying the pressure. When the gradient exceeds 1 : 3, knotted ropes are often used, though this entails an expensive and troublesome dis-

placing and renewing of the knots, and is attended with a good deal of wear on the rope.

An endless draught rope is used. The driving and tension gear resemble those in rope haulage, except that the pulleys are as large as possible (up to 10 ft. diameter). The velocity attained is one to two yards per second.

FIG. 128.

Stations.—In addition to the terminal stations, others have to be provided at points where the direction of the line deviates from a direct course; and in very long lines, intermediate stations are erected about every 6,000 yds. At the stations the line rope terminates in rails mounted on shoes at the one side. Switches,

points, turn-tables and shunting platforms enable the traffic to be adequately dealt with. As the skips are pushed forward by hand

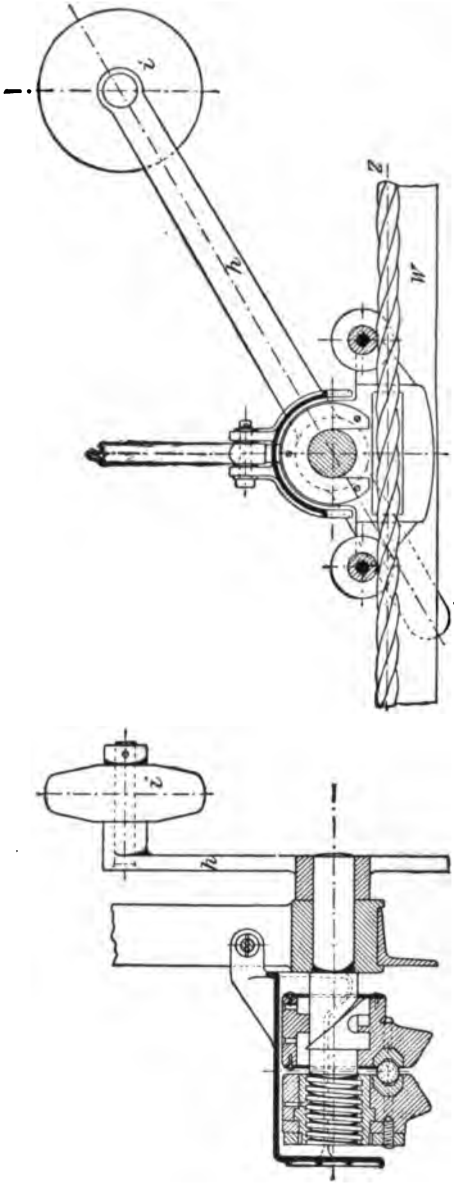


FIG. 129. (*Note.*—Z = draught rope; W = skip strut.)

on arriving at the station rails, they require to be previously (automatically) detached from the draught rope. In the case of the Pohlig clutch, all that is necessary to free the rope is to turn the

loaded lever, *h*, attached to the screw spindle, from right to left, an operation easily performed (see Fig. 130) by the aid of a suitably bent iron bar, *r*, whilst the recoupling is effected by a guide rail and a fixed striker, *g*.

When the arrival station is on a much lower level than the starting-point, *i.e.*, the loaded skips run downhill, no motor is required, the driving pulley being fitted with a brake instead.

Wire tramways are suitable where materials have to be conveyed over long distances and the contour of the surface is unsuitable for laying a fixed track, or difficulties are encountered in acquiring the land; also when mountain gorges, water-courses, streets or railways have to be crossed, an elevated track is some-

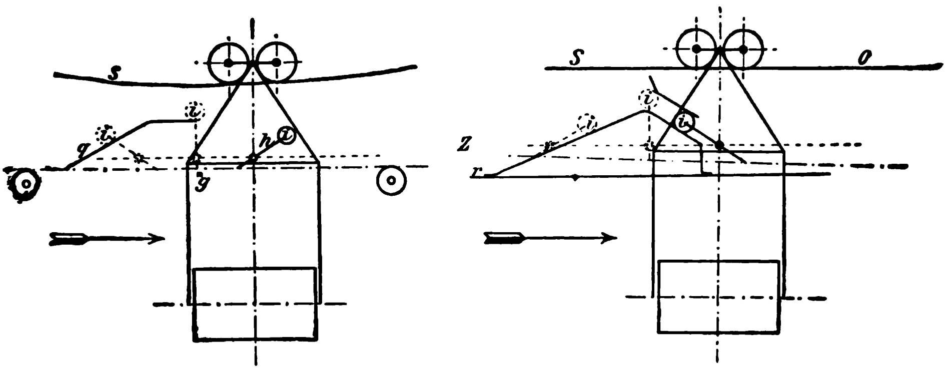


FIG. 130. (*Note.*— O = top edge of rail; Z = draught rope.)

times desirable owing to the frequency of floods, snowdrifts, etc. About one to three skips can be conveyed per minute, the maximum carrying capacity being some 80 tons an hour. Where the traffic is greater two tracks must be constructed.

Now and again endeavours have been made to directly connect underground haulage with wire-rope tramways, the hanging rails being extended into the haulage road, or by constructing the skips in such a manner that they can be placed on tub frames, and thus transported on the fixed tracks.

II. Locomotive Haulage.

Locomotives are used :—

1. In drift work for hauling trains of tubs to the outcrop.

2. To replace horse traction where the erection of rope haulage plant is impracticable owing to the road being too narrow for more than a single track, or containing too many turns, or because the traffic is too small.

The track should be nearly horizontal, otherwise the weight of the engine will have to be excessive, or the train shortened. The engine should be as compact as possible, in order not to unduly impede ventilation.

Care must be exercised in starting and shunting the trains, the component tubs being unprovided with buffers or elastic couplings. Mention has already been made of another disadvantage of train haulage, *viz.*, the accumulation of tubs at the road ends.

Engine-power.—Tractive force, 4-60 cwt.
Weight of load, 2-18 tons.
Speed of haulage, 30-120 ins. per second.

Motive-power.—Steam, gas, benzine, compressed air, electricity.

Ordinary locomotive engines heated by direct fire are used only in ore mines (return airways) and drifts.

The hot-water locomotive and Honigmann's soda locomotive are only used here and there. The first named has no fire-box but carries a tank filled with water superheated, *e.g.*, by means of high pressure steam blown in. From this tank the supply of steam for the engine is drawn; but of course the steam pressure is a progressively diminishing quantity, as also the water temperature, and hence the engine must be recharged after a short time. The steam is very wet, the consumption high, and the refilling troublesome and time-wasting ; but there is no smoke and no risk of ignition.

Honigmann conducts the escape steam of the hot-water locomotive into a tank charged with concentrated caustic soda and immersed in the superheated water tank. The chemical reaction between the steam and the caustic soda generates heat, which retards the cooling of the water in the outer tank.

Gas engines carrying a store of compressed gas are not used in mines, though benzine locomotives have recently been introduced for this work.

According to Mekaski, in compressed air locomotives the wrought-iron air tanks are charged with air under a pressure of 40-60 atmospheres, and this air on its way to the cylinders is passed through superheated water (at 160° C.), whereby it becomes warmed and saturated with water vapour. This enables the air to act with considerable expansion and work in a very favourable manner. The provision of the necessary mains and charging stations in the pit is, however, difficult.

Electric Haulage.—All the above-mentioned systems are insignificant in comparison with electric haulage.

The continuous current is generally employed; more rarely polyphase current or accumulators. The current is supplied through a naked line wire fastened to the roof of the haulage road, or through a contact rail, the return current flowing through the track rails or a separate cable. The current is collected by rollers, pulleys or arched slides.

Line wires must be well insulated and placed at such a height as to be out of accidental contact by the workmen.

Brick-lined galleries or rock roads are specially adapted for electric haulage; but in very damp galleries, or where the rock pressure is high, constant supervision and repair are necessary.

CHAPTER VII.

THE WORKING OF UNDERGROUND ENGINES.

IT is only in exceptional cases that power generated above-ground is transmitted to the pit by means of shafts, rods or wire ropes, the motive-power for underground haulage engines being mostly supplied by steam, compressed air, hydraulics or electricity.

The three last named are almost always generated by the aid of steam, and the total efficiency in plant with transformed energy is naturally lower than where steam is employed direct. Consequently, where the latter method is practicable, and the peculiar properties of the steam are not injurious to the service of the mine, steam is superior to any of the others for the transmission of power.

(*a*) STEAM.

Boilers are nearly always erected at the surface, the steam being conveyed to the engines by pipes in the shaft. This method is unsuitable for separate driving, but cheap and economical for large engines near the shaft. The carefully insulated pipes must be laid, in such a manner as to be easy of access, in the upcast shaft, and condensation must be provided for. Pipe dimensions must be selected with a view to minimising the cost of steam; narrow pipes with considerable fall in pressure, but little loss by condensation, are preferable to wide pipes. Where extra power is occasionally required, it is better to provide a double set of pipes, keeping only one in use under normal circumstances. A water separator must be provided between the main and the engine. The escape steam must be condensed, a spray condenser being kept in reserve for use in the event of a breakdown in the air pump; or else provision must be made for discharging the waste steam into old workings, an upcast ventilating shaft or special upcast pipe. The underground

engine-room must be spacious, well lighted and well ventilated, or the management of the engine will be attended with difficulty and its life and efficiency will be prejudiced.

(*b*) Compressed Air.

Unlike steam, compressed air does not conduct troublesome quantities of heat into the shaft and workings, and the waste air instead of being a burden is useful for ventilation. There is no loss by condensation in the pipes; and if the latter be carefully laid, the waste by diminution of pressure and by leakage is inconsiderable. Any steam engine may be employed as an air motor; but since air cools considerably in expanding, it is necessary to either work with a small expansion or else warm the air before it enters the cylinders (slight incrustations of ice may be prevented by spraying ordinary pit water into the escape pipe). Heating the air—which is accompanied by a considerable increase in the total efficiency—is best effected by direct fire; but this is seldom practicable in mines, owing to the smoke evolved and the presence of fire-damp and coal-dust in the pit air. Warming by injected superheated steam or clean hot water entails the provision of special pipes.

The working efficiency of the usual compressed air plant—single-stage compression, no preliminary heating or expansion—is very low, and the system is therefore restricted to places where compressed air is already in use for separate ventilation, driving coal-cutting machines, drills, etc.

(*c*) Hydraulic.

Unlike steam and air, water is inelastic, and permits the attainment of merely a low speed; hence, wide pipes are required for low pressures, and, for high pressures, the mains are expensive and difficult to keep watertight. Moreover, economical working entails, in large hydraulic engines, pressures of 100 atmos. and more. Low pressure motors may be installed when the water can be derived from the delivery pipe of the pumping plant,[1] or from an

[1] Good pumping engines consume 2¼ lb. of best coal in lifting 50,000—60,000—70,000 galls. a height of 3 ft. If 4,000 galls. an hour be drawn from a delivery pipe

existing main supplying, for example, the sprinkling service or sprays for separate ventilation, etc. The efficiency is fairly high. Provision must be made for carrying away the tail water.

Hydraulic power deserves most attention in fiery and dusty pits with firm floors.

Plunger machines are employed for high pressures; turbines or Pelton wheels (pressure 5-50 atmos.) for small or medium tasks.

A haulage winch working with endless overhead rope and driven by a Pelton wheel is shown in Figs. 131, 132 (Plate VI.). The original was designed by H. Breuer of Höchst-on-Main.

(*d*) Electricity.

The chief advantage of this form of power resides in the cables, which can be easily laid down anywhere, take up little room, and are not so readily damaged as pipes where the rock is exposed to pressure. Only in fiery pits is the danger of the cable breaking to be feared, and all parts liable to spark—switches and rheostats as well—must be in gas-tight casings. The motors in such cases should be erected in the intake air current, polyphase brushless motors being preferred. The insulation must be carefully seen to, and all wooden linings avoided. Where a cable comes in contact with wood, an underlay of asbestos must be inserted, to prevent ignition. In damp pits iron-shod cables are best; the motors must be mounted on insulated foundations, and the switch-levers be provided with ebonite handles, etc.

In this system the attendance on the motors is easy, and the efficiency high even in small motors; and there is no loss of energy when the machinery is at rest.

In choosing motors and kind of current, points to be considered are: whether the starting will be under a full or a small load; whether the tractive force is constant or greatly fluctuating, the speed constant or variable; whether, in the event of an accident,

500 ft. high, the effective water-power thus obtained will be about 10 h.-p., whereas the increased consumption of coal by the pumping engine will not exceed about 22 lb., or 2¼ lb. for each 1 h.-p. utilised in the pit. This figure is almost inappreciable in augmenting the working expenses of the pumping plant, since the latter has to bear nearly the whole of the charges for attendance, depreciation, etc.

the load can be suddenly thrown off, or a sudden overload produce complete stoppage,[1] such as may happen through the breaking of

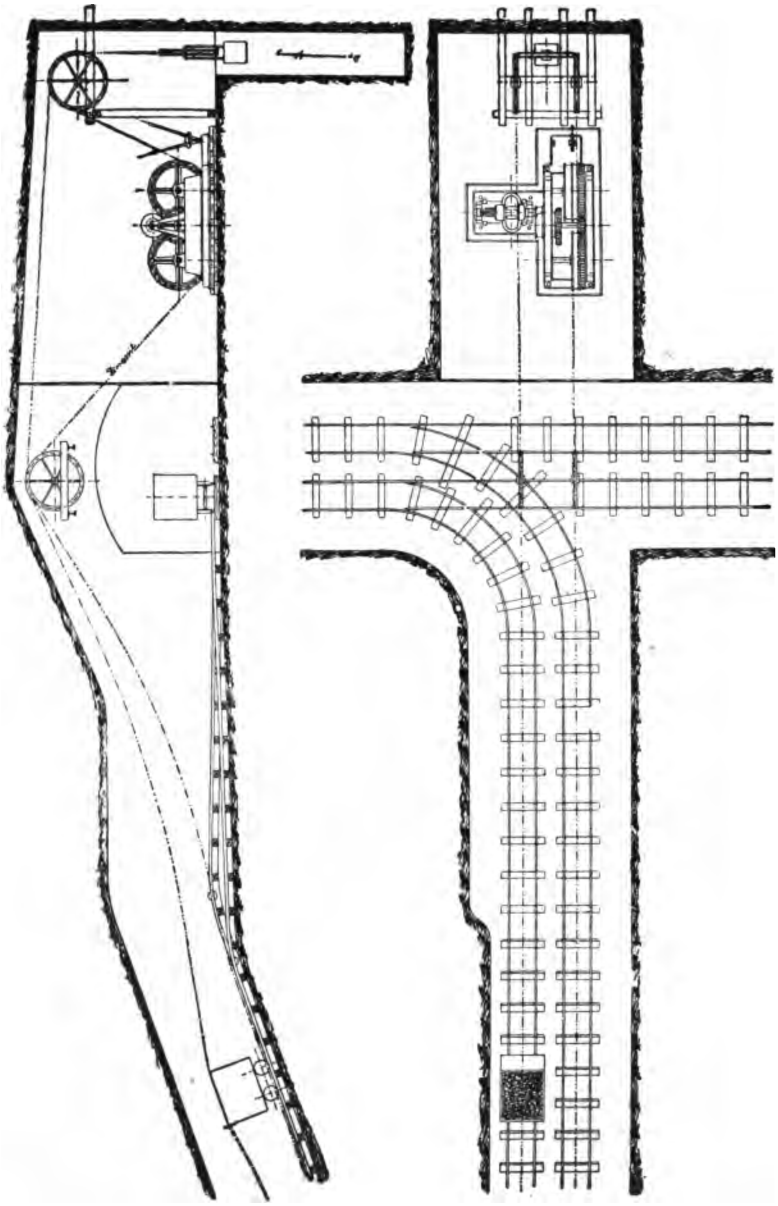


FIG. 133.

[1] Apart from electrical safety appliances, the motor can be protected from overloading by the insertion of a friction clutch or gear between the shafts of the motor and drum. When the strain becomes excessive the coupling slips. The racing of continuous-current motors when running empty can be prevented by means of a centrifugal governor acting on the cut-off switch.

the rope or derailing of a tub in hauling with overhead ropes; whether sparking at the motor and switches can be obviated; and whether the motor is to run continuously or only for short periods, mostly under full load or light loads; and so forth.

Electric winding engines are often fitted with a special emer-

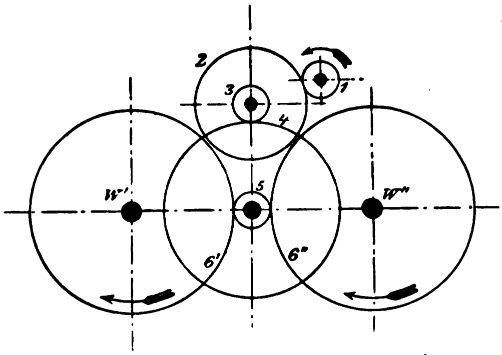


FIG. 134.

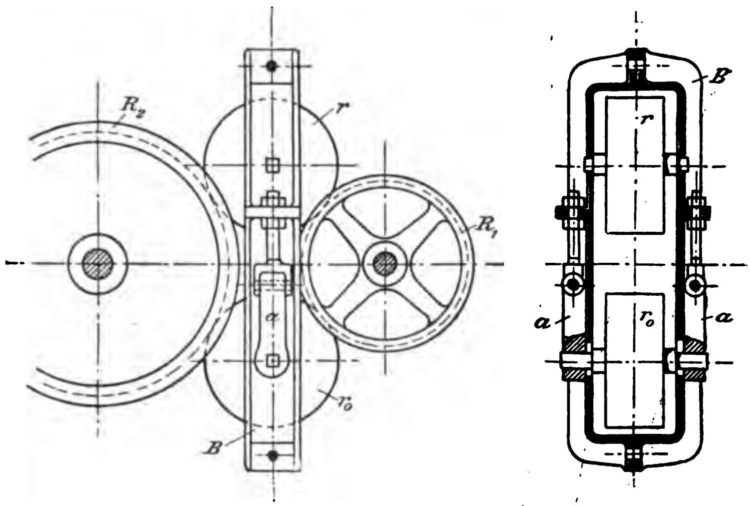


FIG. 135.

gency brake coming into action on the cessation of the current from any cause while the miners are being conveyed to or from the pit. The brake-lever is loaded with a heavy weight, but sustained by a powerful electro-magnet, so that, if the current fails, the lever drops and the brake stops the drum.

Fig. 133 shows the arrangement of an electric haulage road

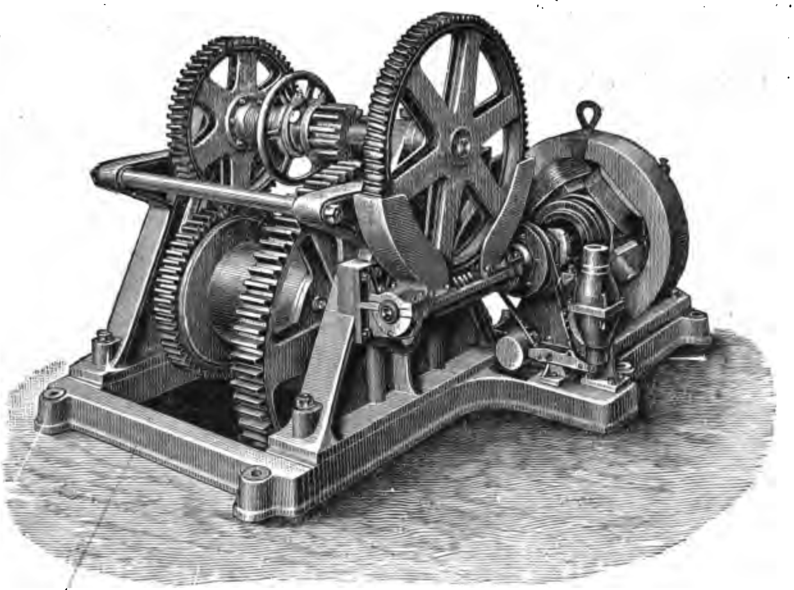


FIG. 136.

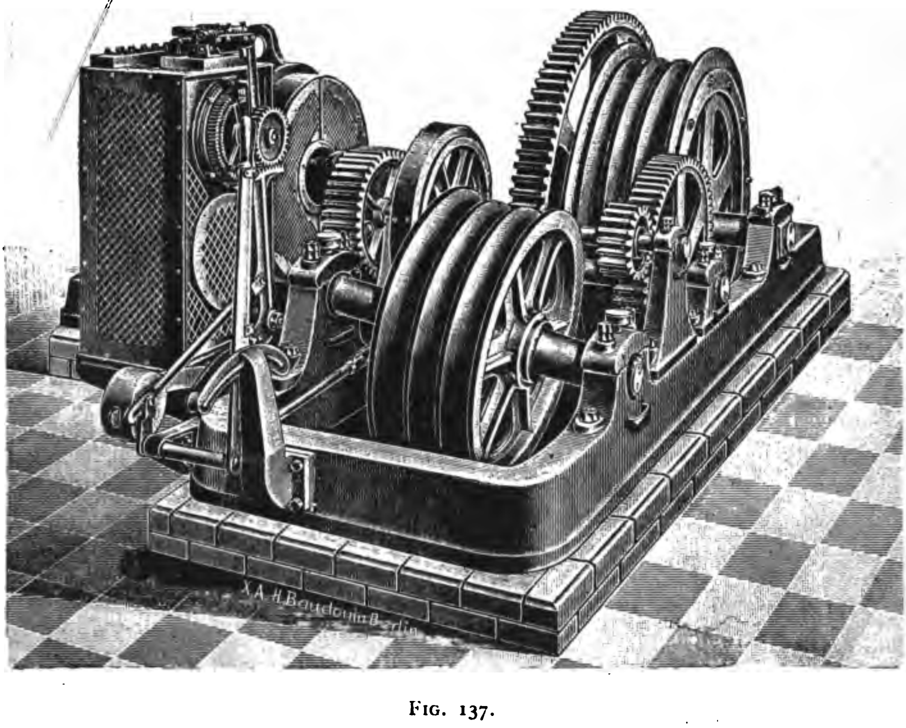


FIG. 137.

according to Hoppe. The method of guiding and tightening the rope needs no further description ; and the mode of driving can be seen from Fig. 134. The motor shaft carries a toothed wheel, 1,

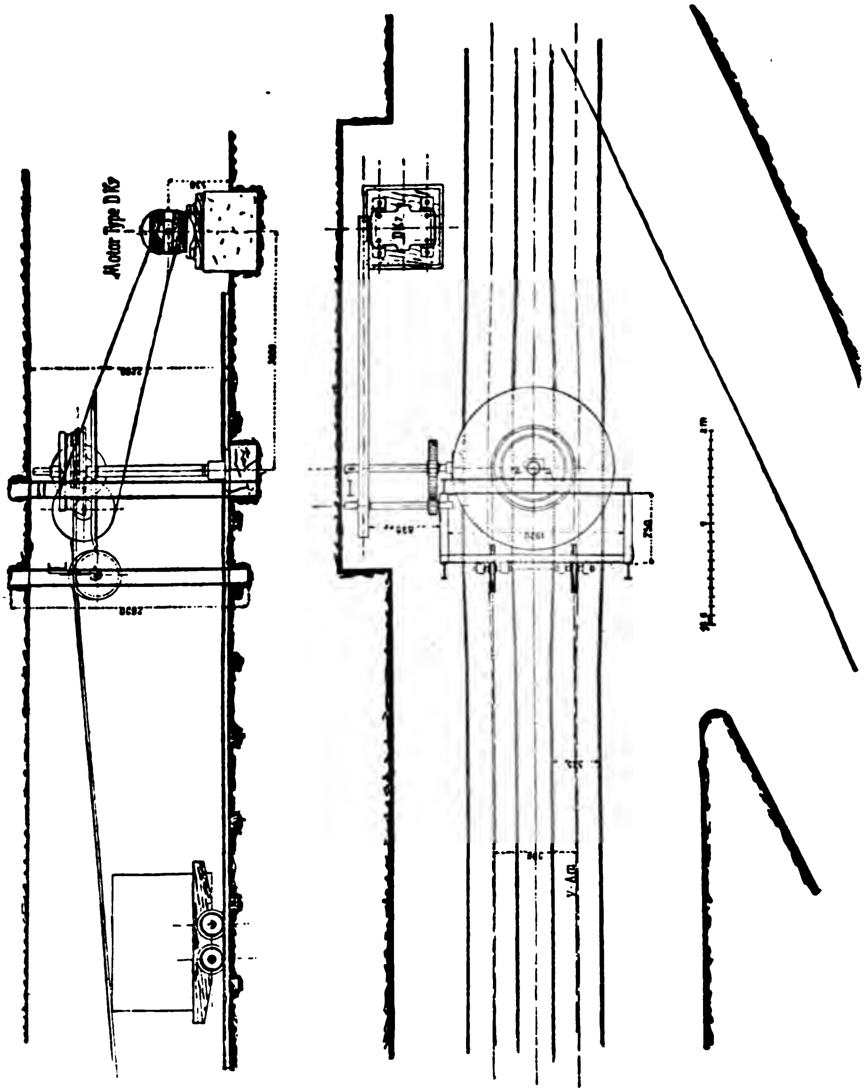


Fig. 138.

and the driving and counter-pulleys are mounted at w' and w''. If, as in this case, both pulleys are actuated, then, when three turns of the rope are given, the effective arc embraced is $= 6\pi$, but only $3 = \pi$ when the one pulley is used merely as a guide. Thus the

tractive force can be doubled for the same number of rope turns, but the strain on the rope is unfavourable. In place of the cog gearing,

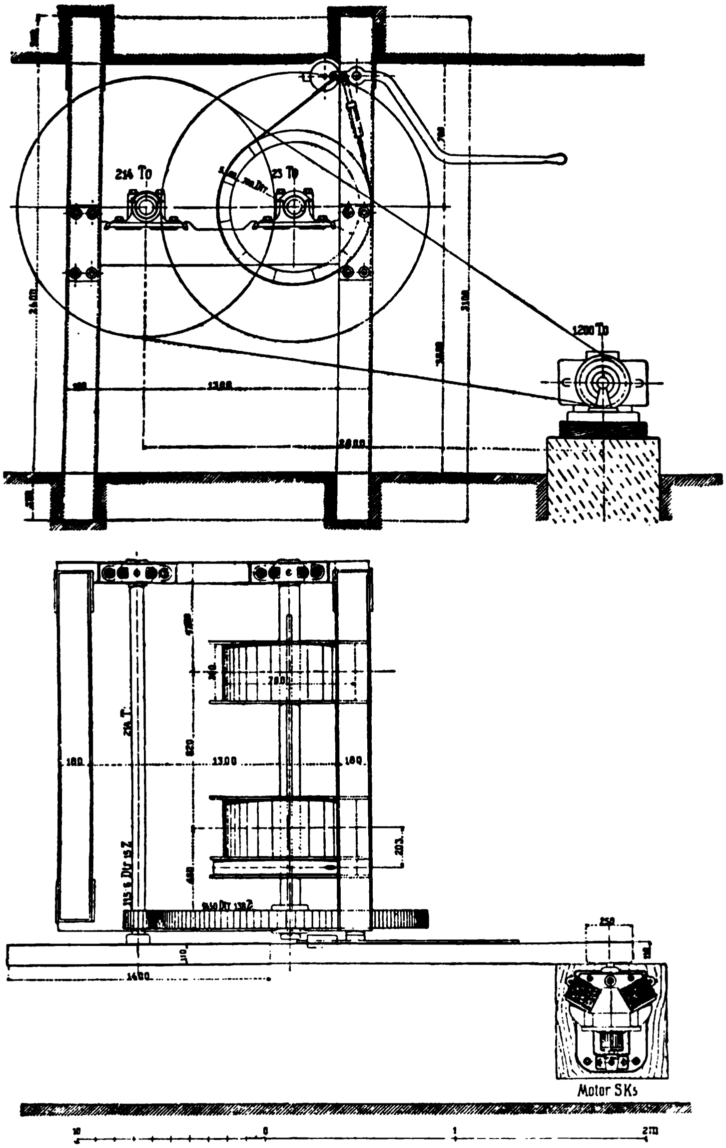


FIG. 139. (*Note.*—To = revolutions; Z = teeth.)

1-2 (1 being usually a raw-hide spur wheel or a phosphor bronze cone wheel), Hoppe often uses friction wheel gear, as in Fig. 135, R_1 being mounted on the motor shaft; r and r_0', friction rollers of

leather, raw-hide or millboard, mounted in the bow, B. The axis of r_0 is adjustable in a longitudinal slot. The two rollers can be drawn together, and pressed against the friction wheels, R_1, R_2, by means of set screws and a rubber block, *a*.

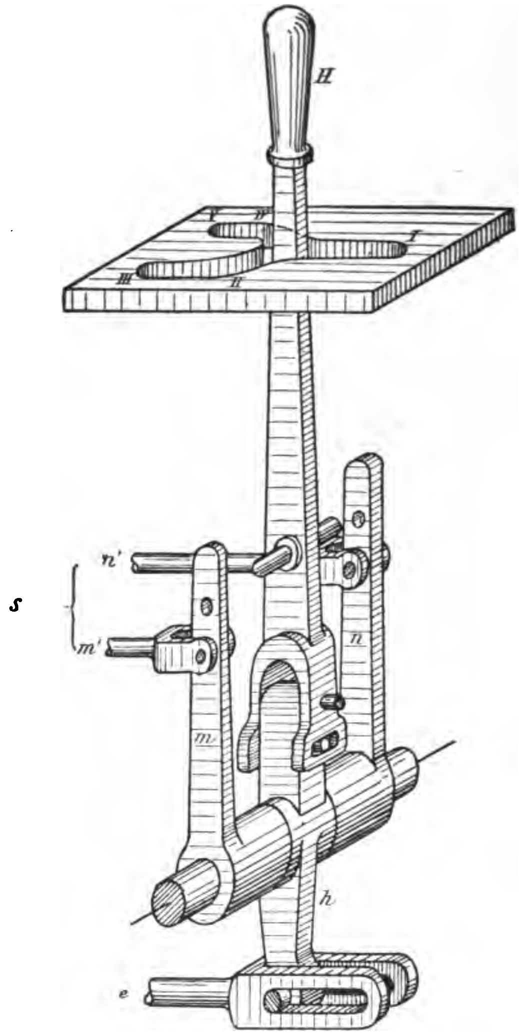


FIG. 140. (*Note.*—S = to the switch-levers; *e* = to the brake.)

Fig. 136 shows a worm-geared haulage winch made by the Allgemeine Elektrizitäts-Gesellschaft, Berlin, fitted with an electric brake and two-speed gear. The worm-wheel shaft carries two

detachable cog wheels, enabling the drum to be driven at a higher or lower speed.

Figs. 137 and 138 represent electrical systems of chain haulage, the former being by Hoppe, and the latter by Siemens & Halske of Berlin. This firm also makes the winch shown in Fig. 139.

Fig. 140 is the Siemens & Halske reversing gear. The lever, *h*, articulated on the hand-lever, H, acts on the brake, and sets it on when H is pushed up to I. (the end of the Y-shaped slot). On pulling forward the lever, the brake is gradually released; and by pushing H into the branch slots II. III., or IV. V., the levers, *m* or *n*, respectively, are set in motion. These latter are connected with the starting-switch and the rheostat, so that, when H is moved from II. to III., or from IV. to V., the circuit is completed for forward or backward running, and the resistances are shut out *seriatum*. The motor cannot be started while the brake is on; and the resistances being gradually shut off before the coils receive the full current, a sudden reversal is impossible. In this way a single lever is sufficient for the brake, starting and reversing gear.

The controlling switches used in electric street cars are also suitable for hoist winches; and the same applies to various other details (spring bearings for the motor, brushes, and so forth).

CHAPTER VIII.

MACHINERY FOR DOWNHILL HAULAGE.

MACHINERY for lowering loads down inclines, etc., is employed for delivering packing waste, lowering coal, etc., from higher workings to the main haulage roads (especially in open cast workings), in unloading, in preparatory plant, etc. Gravity is the motive power, the excess of energy being necessarily taken up by means of brakes.

BRAKE INCLINES.

The arrangements are identical with those for haulage through ascending inclines, except that the driving mechanism is replaced by a brake winch, consisting mainly of the driving drum or pulley and a brake. The methods of laying the track, coupling the tubs or trucks, guiding the rope, and constructing the drums, pulleys and brakes, differ but slightly from those already described.

The haulage may be single- or double-acting, the latter being more frequently used in open workings, with open rope, or endless rope or chain; whilst the single method is more in use for underground work, as taking up less room. The tub is attached to one end of the rope, the other carrying a counterpoise, which is drawn up by the descending full tub and afterwards raises the empty. The usual weight for this counterpoise is equal to the empty tub, plus half the net load. In double-acting brake inclines the excess weight generating motion is therefore equal the load, but in single inclines equal only half the load. Hence it follows that the single method is inapplicable for inclines of low gradient (below 8°), whereas the double-acting system may be used on gradients down to 3°, in proportion as the trains are lengthened and the tubs easy running.

Overhead rope or chain is recommended for slight gradients.

and long roads. The rate of haulage is 2½-5½ yds. In single tracks, the rails for the counterpoise are generally laid inside the main track, and in such case the weight, having to pass under the tubs, must be as flat as possible. It usually consists of a shallow

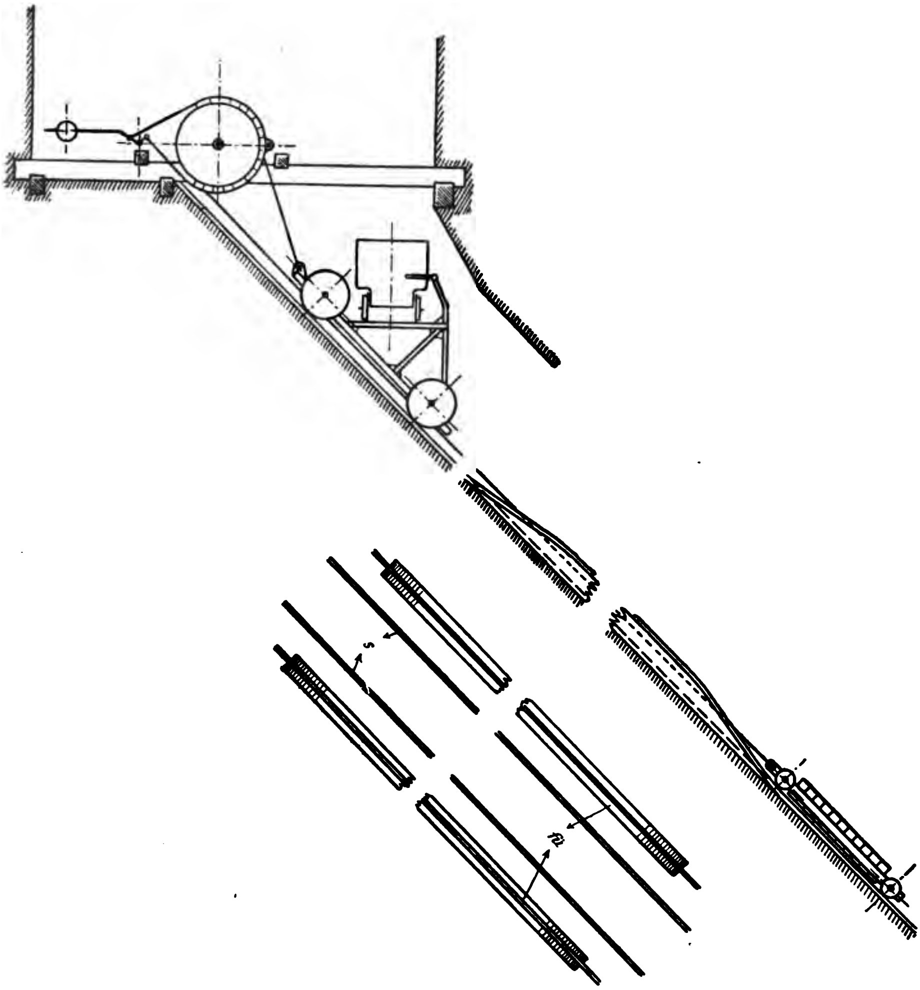


FIG. 141. (*Note.*—*s* = track for counterpoise; *fü* = main track.)

truck mounted on four wheels, and loaded with stones, fragments of iron, or water, according to requirements. In view of easy conveyance, it is better, however, to form the counterpoise of a number of plates bolted together, and surmounted with rollers, to keep the rope from chafing against the edges of the weight. If the main

track be raised at the meeting-point, as shown in Fig. 141, then the dimensions of the counterpoise need not be so restricted. The elevated rails are carried on longitudinal sleepers cut to the proper shape.

The brake engine consists of the rope drum or pulley, and the brake. Pulley brakes are lighter, easier to mount and dismount, and occupy less room than drum brakes, and are therefore better adapted for pit work. In order to prevent the slipping of the rope in the pulley groove, the conditions already laid down must be fulfilled. The friction is increased by wedge-shaped grooves or by giving several turns to the rope. The pulley shaft is mounted horizontally for single track work, but vertically for double tracks. Rope pulley and brake rim are mostly cast in one piece, or the brake is applied to the outer rim or sides of the pulley, though in this event the heat generated is injurious to the rope. Drum brakes are fitted either with two drums, or with only a single one round which the rope is wound three or four times (Fig. 142). This saves room and rope, but, to ensure the rope coiling evenly on the drum, guides have to be provided, and thus the advantages are counterbalanced. Coiling guides are also required when the first guide pulley is mounted very close to the drum. The rope is gripped by two rollers which are mounted on a small truck or slot receiving motion, like a lathe tool-rest, from a screw spindle actuated from the drum shaft. A simpler plan (Fig. 143) is to provide the hub of the guide pulley with a female thread and mount it on a fixed screw spindle, on which it revolves and travels by the influence of the rope. The pitch of the thread must correspond to the thickness of the rope.

Large brake winches, unless fixtures, are usually mounted on a wooden frame. Fig. 144 shows a means of rapidly fixing up iron pillars (for mounting the drum journals) tight against roof and floor. Large winches should be also fitted with a hand-crank, and where necessary, with detachable gear, for turning the drum shaft, in order to lift the empty tub in case of breakdown, adjust the rope, etc.

Band brakes are generally used, and must be "self-acting," *i.e.*, normally kept pressed against the drum, etc., by weights or springs,

and eased by a foot-lever when haulage is proceeding. Emergency brakes, to enable the load to be arrested instantly, in case of need, are also fitted in the same way, the lever being loaded by a heavy weight but prevented from applying the brake, by a nose or cam, until the latter is withdrawn.

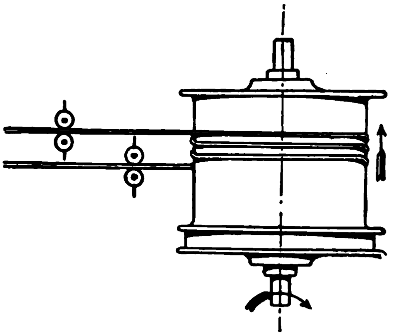


FIG. 142.

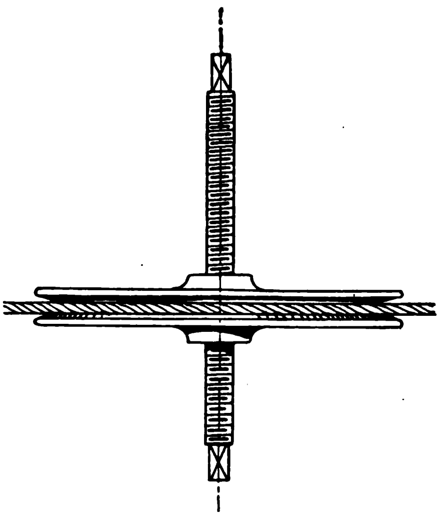


FIG. 143.

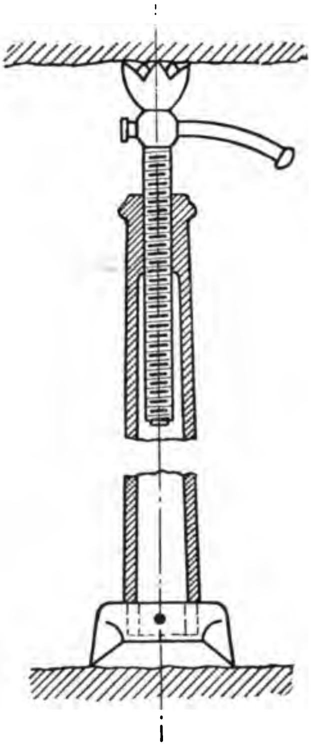


FIG. 144.

In very long brake inclines, especially with continuous endless rope haulage, declivities in wire-rope tramways, etc., the band brake is occasionally supplemented by vane brakes for keeping the velocity within given maximum limits. These brakes consist of large air vanes or smaller water paddles, driven from the shaft of

the drum or pulley. The resistance opposed by air or water to the movement of these vanes takes up the greater part of the excess

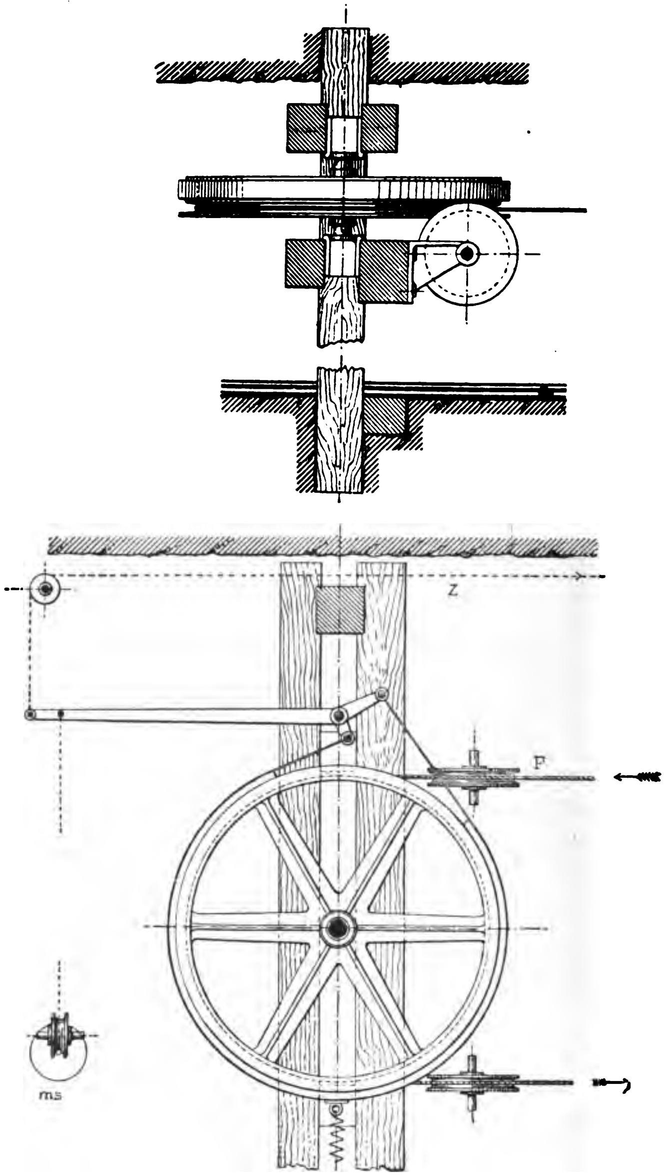


FIG. 145. (*Note.*—Z = brake cord; F = haulage rope; *ms* = brake weight.)

of gravitation, thus facilitating the management of the winch and securing uniform velocity.

Fig. 145 represents the station at the head of a brake incline

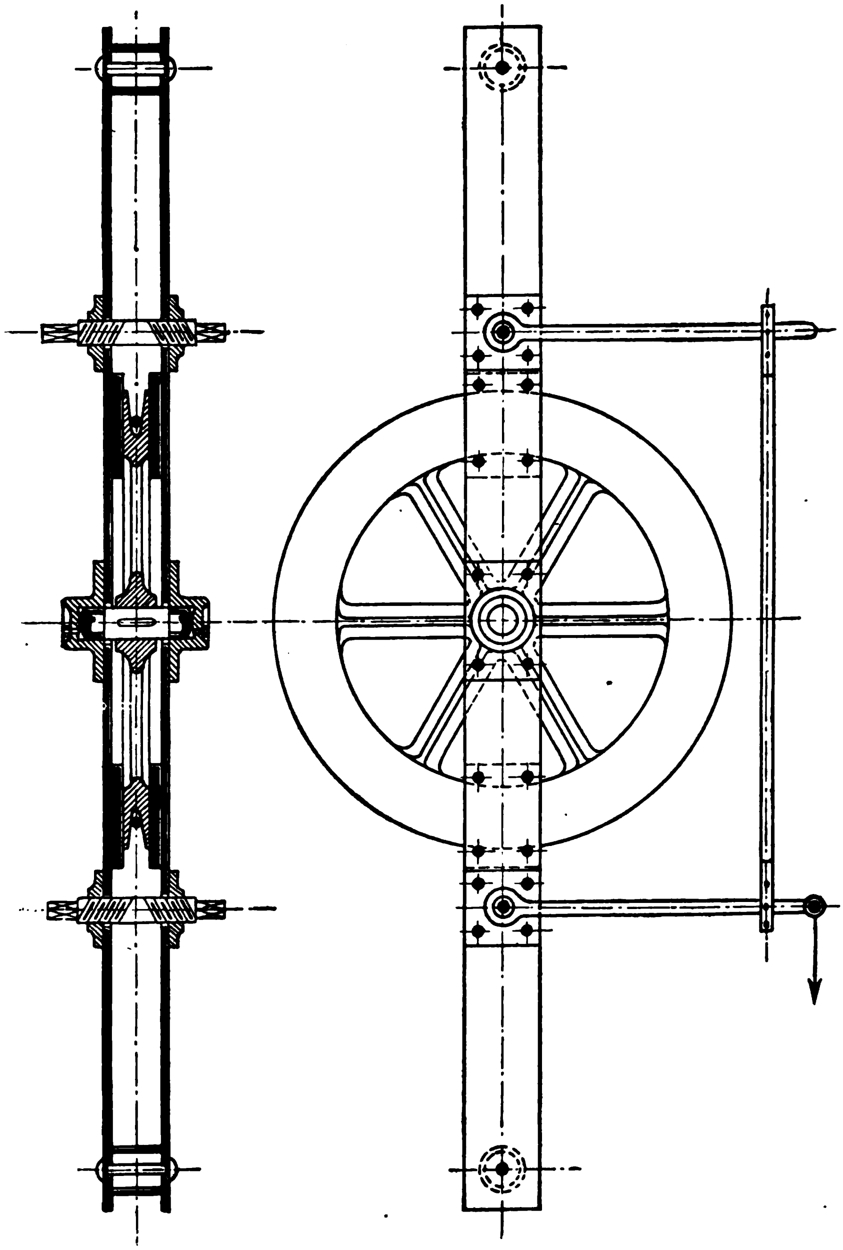


Fig. 146.

with endless overhead rope. The dotted brake cord reaches to the bottom of the incline and serves to ease the brake.

The Vanhassel pulley brake is shown in Fig. 146, the frame of two flat iron bars being utilised as a brake, by screwing up the brake blocks against the sides of the pulley with the aid of right- and left-handed screws.

Hauling from Different Levels.—Fast-and-loose-drum brakes

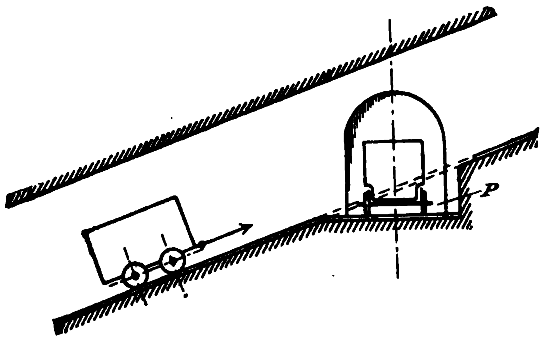


FIG. 147.

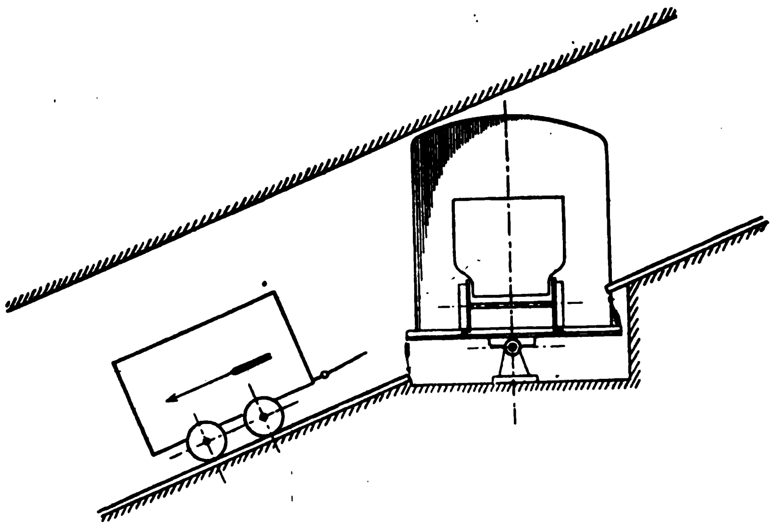


FIG. 148.

are used, the rope being coiled as in winding drums; or where pulley brakes are employed, extra lengths are attached to the rope. A simpler plan than hooking the tub, truck or counter-weight to the rope end is to wind the lower end of the rope round a small drum as reserve, and attach this drum to the tub, etc., in such a manner as to prevent the unwinding of the rope.

Where tubs are delivered to the brake incline from branch roads, the main track must be interrupted (Fig. 147), the tub being turned on the turn-table, P, and hooked on to the rope. In lowering from higher levels, the brake is bridged over by short lengths of rail. Turn-tables of the kind shown in Fig. 148 are also used, the tub

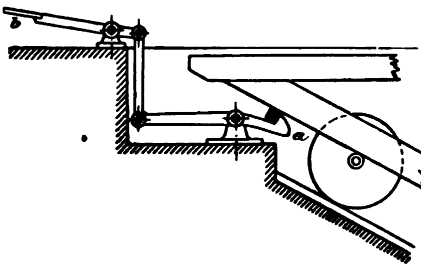


FIG. 149.

from the branch road being run on to the horizontal table, turned and hooked on to the rope, the table being then tilted to the same angle as the main track. The table can be fixed in both positions.

Taking up Rope Stretch.—The rope is liable to stretch in use, a source of trouble, especially in double-track haulage, since the

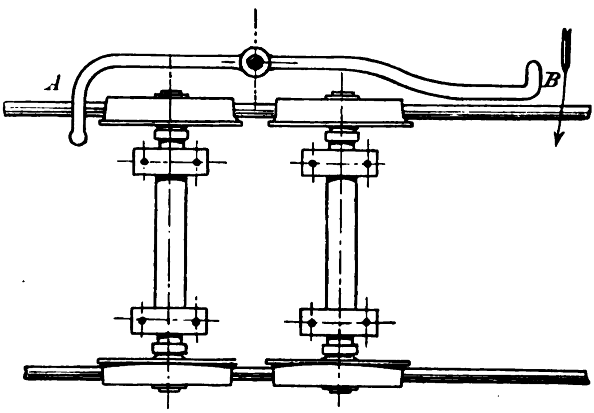


FIG. 150.

truck then does not draw up far enough and the changing of the tubs becomes difficult. The extra length can be taken up by turning the loose drum, shortening the bridle chain, or adjusting a screw between the rope cap and the tub hook.

Safety Appliances.—While the tubs are being changed the truck is held fast, the simplest device for this purpose consisting of a hook,

a (Fig. 149), which engages with a bar under the ascending truck. When the full tub has been pushed on, the attendant presses down the lever, *b*, and then first eases the brake. If the tubs are hooked direct on to the rope, some means must be provided for pre-

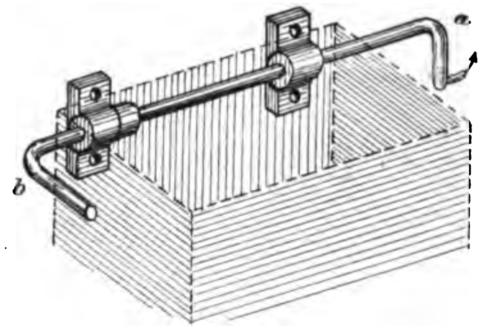


Fig. 151.

venting them running away before they are properly coupled. In Fig. 150 a curved iron bar is pivoted near the rail, a lug, A, stopping the tub from running away. On turning the lever in the direction of the arrow the tub is released, B at the same time closing the track to

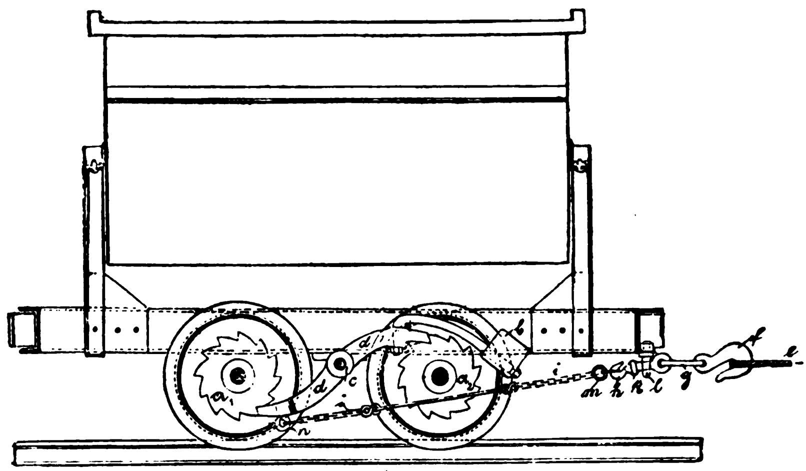


Fig. 152.

any other tubs. The reascending truck pushes B aside and returns the stop, A, to its original position. Another stop, also used for branches opening on inclines, is shown in Fig. 151. Here a rotable bar with bent ends, *a* and *b*, is mounted in two staples. The

heavier end, *a*, hangs down, whilst *b* bars the track. The obstacle is removed by turning *a* in the direction of the arrow.

Stops for trucks have already been mentioned (p. 20), and there only remain to be dealt with such appliances as are fitted on the track. These include strong protective walls at the bottom of the incline, for catching the descending truck if the rope breaks, and preventing injury to workmen there. (Particularly necessary when the incline opens into a sloping road.) In long inclines, it is often the practice to set up, at intervals of 40-50 yds., crossbars that lie flat between the rails, but can be raised by pulling a cord,

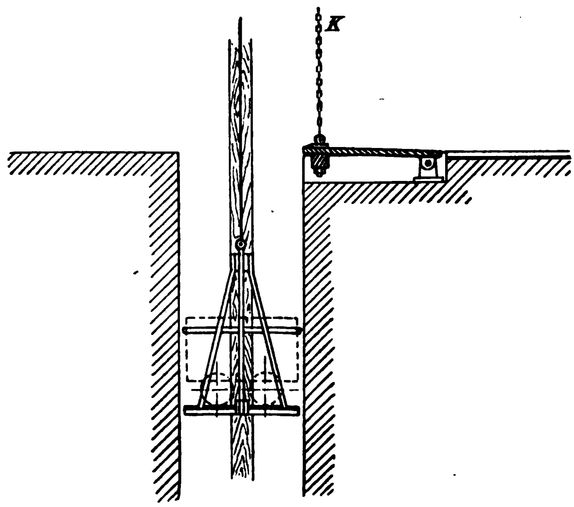


Fig. 153.

and then stop the tubs. The same effect can be produced automatically in endless rope or chain haulage, should an ascending tub break loose and run away downhill, pivoted barriers being provided that are opened by the ascending tubs but bar any progress in the opposite direction.

Safety catches have been devised for acting in the event of a tub running downhill very fast. To this class belongs a lever that is pushed aside by tubs descending at normal speed, but when one runs away the sudden impact on the levers releases stops which bar the track. Finally, mention may be made of the new tub brake designed by Neitsch (Fig. 152) for gradients up to 15 per cent.

Should the rope break, the counterpoise, *b*, releases the double pawl, *d* (which is normally kept raised by the pull of the rope), thus stopping the tub.

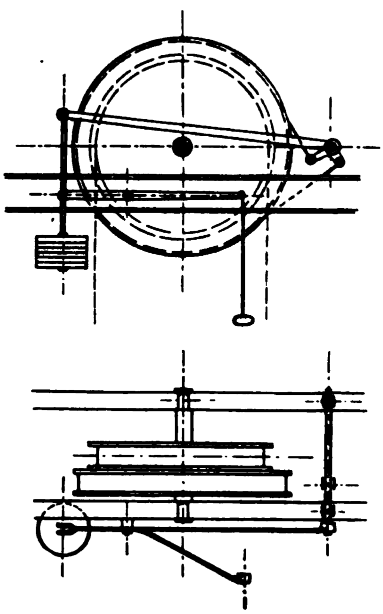


FIG. 154.

BRAKE ENGINES FOR WINDING.

These machines, mostly arranged for double action, consist of drums and brakes. In confined spaces driving pulleys are chosen; and for short lifts, above-ground, the rope may be replaced by a chain.

The tubs to be lowered are placed on cages, fitted with guides, and lattice doors to the shaft, as in upward winding. Keps are recommended for safety, though

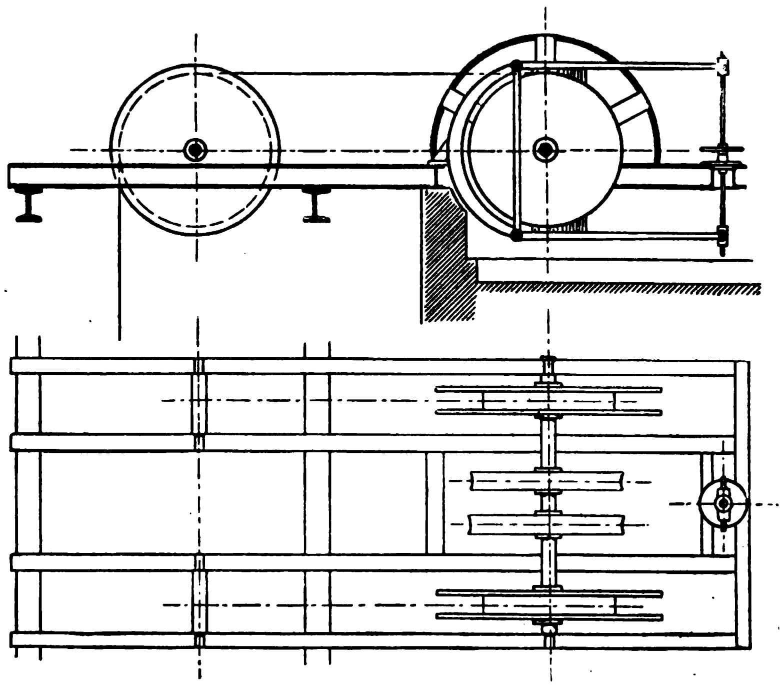


FIG. 155.

not essential; besides, the rope is strained if the cage is slung while the tubs are being changed. Since, unless a hand crank and detachable gear be provided at the drum shaft, the cage cannot be raised off the keps before lowering, the latter if used at all must be pushed under the cage and withdrawn laterally. Or hooks (Fig. 149) engaging under a bar at the head of the cage may be used. The stretch of the rope is taken up in the manner already described, or by mounting the drum in adjustable bearings. In Fig. 153 the edge of the delivery floor is pivoted, and can be set to the proper height by the chain, K, and a pulley block.

Fig. 154 is a brake for derrick use, and Fig. 155 is a large brake engine fitted with flanged pulleys and powerful brake blocks.

Utilising the Force of Gravity.

In ordinary brake inclines, etc., the excess energy due to gravitation is nullified by brakes; but under special local conditions this energy can be utilised for raising loads, by connecting the brake engine shaft to a hoist or haulage-road pulley.

INDEX.

I.

K.

L.

M.

N.

O.

P.

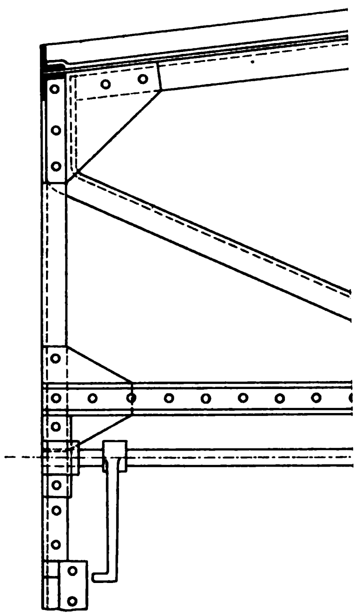
R.

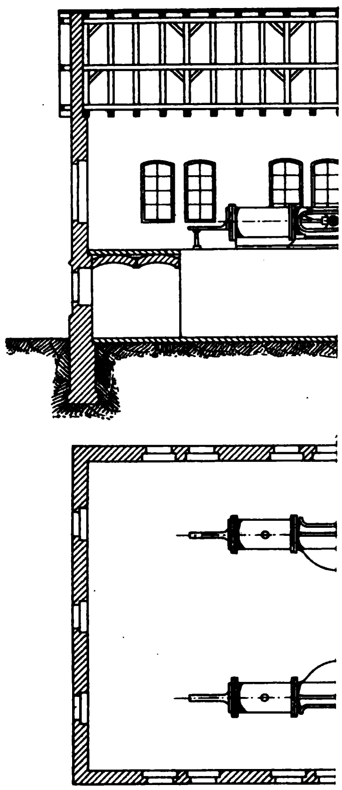
S.

T.

THE ABERDEEN UNIVERSITY PRESS LIMITED.

Fig. 34.





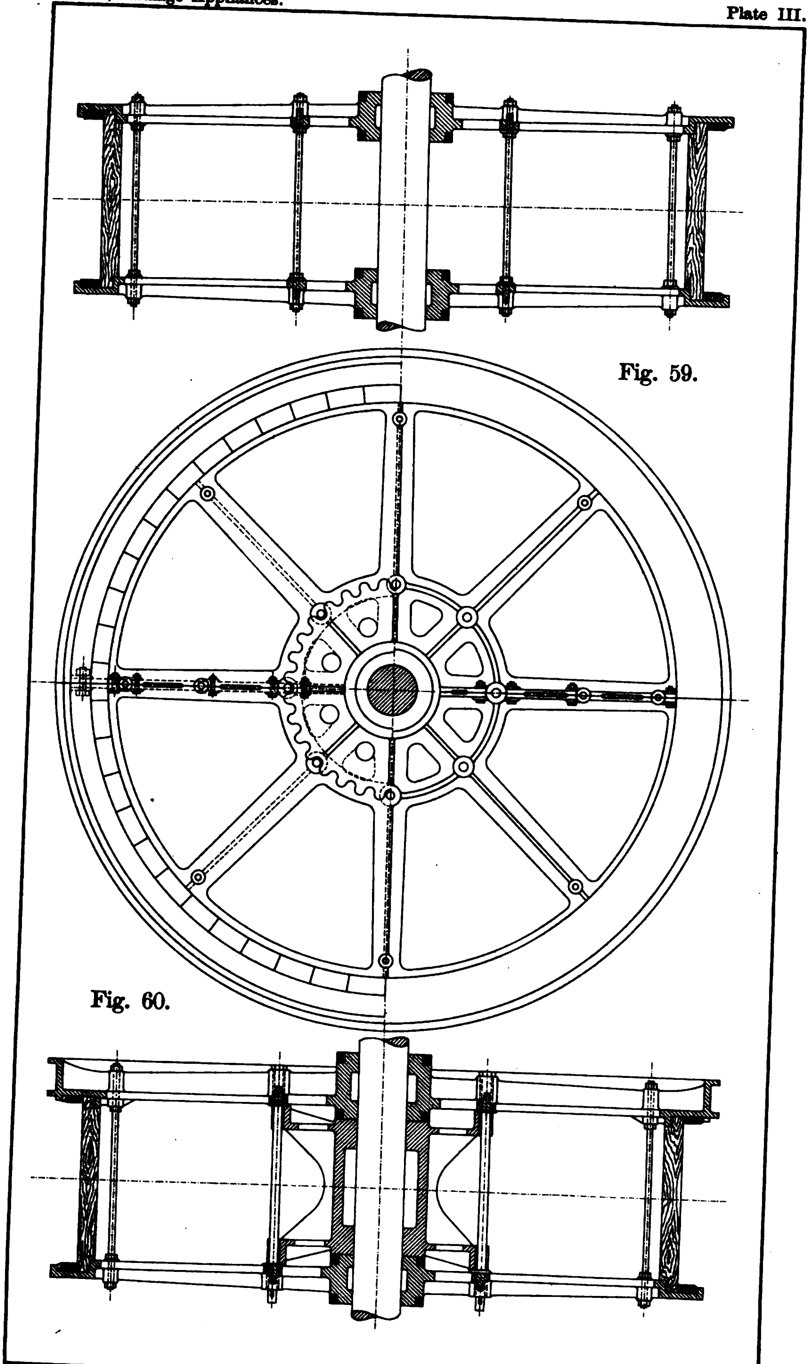


Fig. 59.

Fig. 60.

Specially printed for Scott, Greenwood & Co.

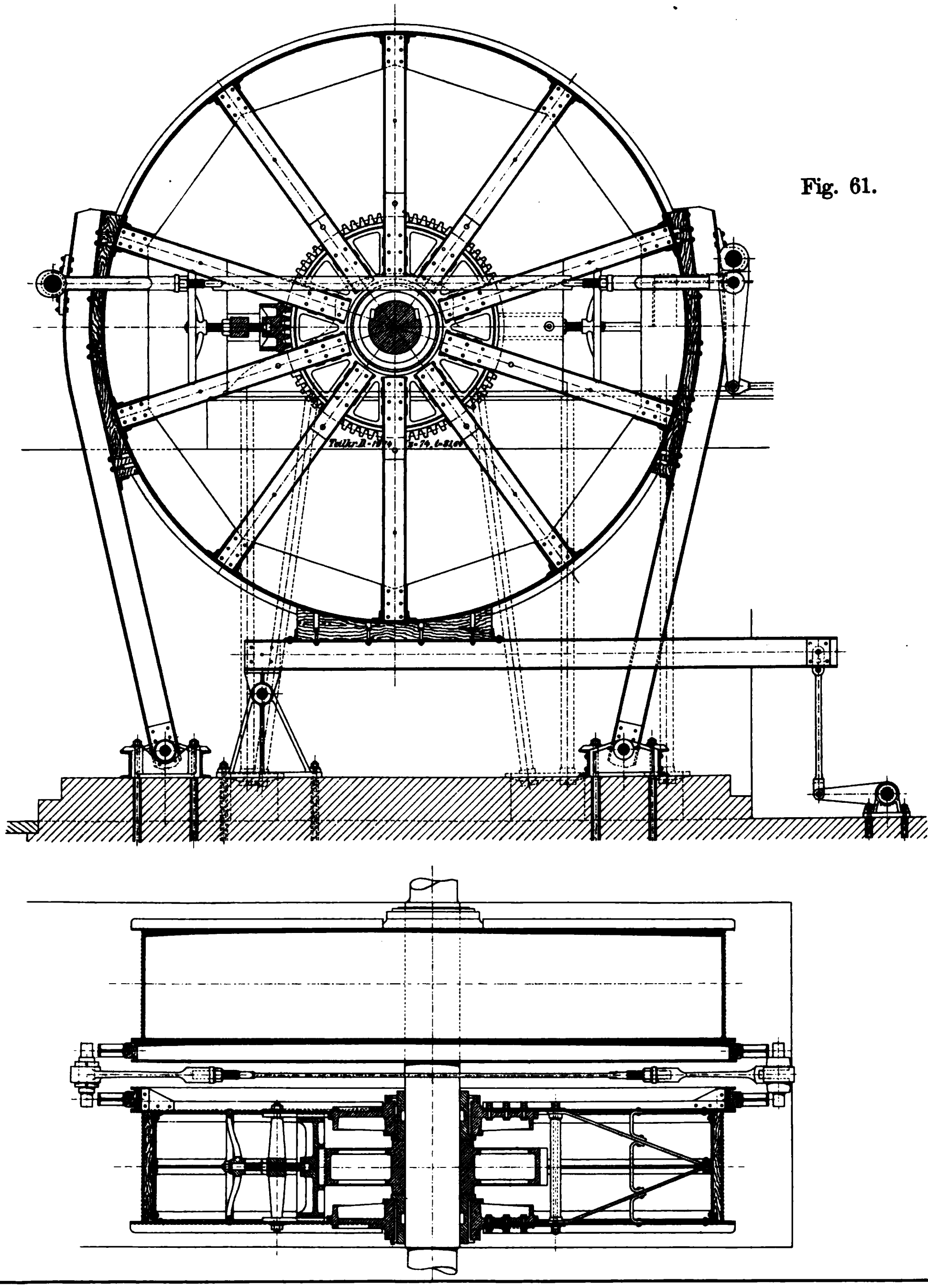
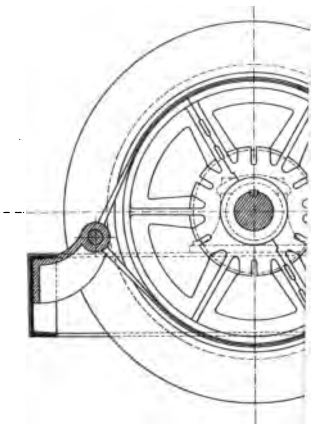
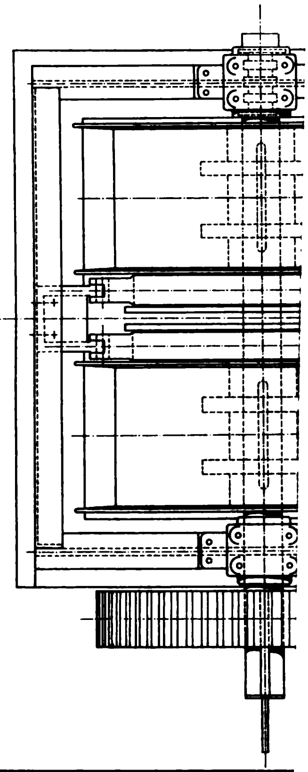


Fig. 61.

Specially printed for Scott, Greenwood & Co.





DECEMBER, 1903.

Catalogue

OF

Special Technical Works

FOR

MANUFACTURERS, STUDENTS, AND TECHNICAL SCHOOLS

BY EXPERT WRITERS

INDEX TO SUBJECTS.

SCOTT, GREENWOOD & CO.,

19 LUDGATE HILL, LONDON, E.C.

Tel. Address: "PRINTERIES, LONDON". Tel. No. 5403, Bank.

Paints, Colours and Printing Inks.

THE CHEMISTRY OF PIGMENTS. By ERNEST J. PARRY, B.Sc. (Lond.), F.I.C., F.C.S., and J. H. COSTE, F.I.C., F.C.S. Demy 8vo. Five Illustrations. 285 pp. 1902. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

THE MANUFACTURE OF PAINT. A Practical Handbook for Paint Manufacturers, Merchants and Painters. By J. CRUICKSHANK SMITH, B.Sc. Demy 8vo. 1901. 200 pp. Sixty Illustrations and One Large Diagram. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

THE MANUFACTURE OF MINERAL AND LAKE PIGMENTS. Containing Directions for the Manufacture of all Artificial, Artists and Painters' Colours, Enamel, Soot and Metallic Pigments. A Text-book for Manufacturers, Merchants, Artists and Painters. By Dr. JOSEF BERSCH. Translated by A. C. WRIGHT, M.A. (Oxon.), B.Sc. (Lond.). Forty-three Illustrations. 476 pp., demy 8vo. 1901. Price 12s. 6d.; India and Colonies 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

without Chambers—Indian Ink—Enamel Colours—Metallic Pigments—Bronze Pigments—Vegetable Bronze Pigments.

PIGMENTS OF ORGANIC ORIGIN—Lakes—Yellow Lakes—Red Lakes—Manufacture of Carmine—The Colouring Matter of Lac—Safflower or Carthamine Red—Madder and its Colouring Matters—Madder Lakes—Manjit (Indian Madder)—Lichen Colouring Matters—Red Wood Lakes—The Colouring Matters of Sandal Wood and Other Dye Woods—Blue Lakes—Indigo Carmine—The Colouring Matter of Log Wood—Green Lakes—Brown Organic Pigments—Sap Colours—Water Colours—Crayons—Confectionery Colours—The Preparation of Pigments for Painting—The Examination of Pigments—Examination of Lakes—The Testing of Dye-Woods—The Design of a Colour Works—Commercial Names of Pigments—Appendix: Conversion of Metric to English Weights and Measures—Centigrade and Fahrenheit Thermometer Scales—Index.

DICTIONARY OF CHEMICALS AND RAW PRODUCTS USED IN THE MANUFACTURE OF PAINTS, COLOURS, VARNISHES AND ALLIED PREPARATIONS. By GEORGE H. HURST, F.C.S. Demy 8vo. 380 pp. 1901. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

THE MANUFACTURE OF LAKE PIGMENTS FROM ARTIFICIAL COLOURS. By FRANCIS H. JENNISON, F.I.C., F.C.S. **Sixteen Coloured Plates, showing Specimens of Eighty-nine Colours, specially prepared from the Recipes given in the Book.** 136 pp. Demy 8vo. 1900. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

The Groups of the Artificial Colouring Matters—The Nature and Manipulation of Artificial Colours—Lake-forming Bodies for Acid Colours—Lake-forming Bodies' Basic Colours—Lake Bases—The Principles of Lake Formation—Red Lakes—Orange, Yellow, Green, Blue, Violet and Black Lakes—The Production of Insoluble Azo Colours in the Form of Pigments—The General Properties of Lakes Produced from Artificial Colours—Washing, Filtering and Finishing—Matching and Testing Lake Pigments—Index.

RECIPES FOR THE COLOUR, PAINT, VARNISH, OIL, SOAP AND DRYSALTERY TRADES. Compiled by AN ANALYTICAL CHEMIST. 350 pp. 1902. Demy 8vo. Price 7s. 6d.; India and British Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Pigments or Colours for Paints, Lithographic and Letterpress Printing Inks, etc.—Mixed Paints and Preparations for Paint-making, Painting, Lime-washing, Paperhanging, etc.—Varnishes for Coach-builders, Cabinetmakers, Wood-workers, Metal-workers, Photographers, etc.—Soaps for Toilet, Cleansing, Polishing, etc.—Perfumes—Lubricating Greases, Oils, etc.—Cements, Pastes, Glues and Other Adhesive Preparations—Writing, Marking, Endorsing and Other Inks—Sealing-wax and Office Requisites—Preparations for the Laundry, Kitchen, Stable and General Household Uses—Disinfectant Preparations—Miscellaneous Preparations—Index.

OIL COLOURS AND PRINTING INKS. By LOUIS EDGAR ANDÉS. Translated from the German. 215 pp. Crown 8vo. 56 Illustrations. 1903. Price 5s.; India and British Colonies, 5s. 6d.; Other Countries, 6s.; strictly Net.

Contents.

Linseed Oil—Poppy Oil—Mechanical Purification of Linseed Oil—Chemical Purification of Linseed Oil—Bleaching Linseed Oil—Oxidizing Agents for Boiling Linseed Oil—Theory of Oil Boiling—Manufacture of Boiled Oil—Adulterations of Boiled Oil—Chinese Drying Oil and Other Specialities—Pigments for House and Artistic Painting and Inks—Pigment for Printers' Black Inks—Substitutes for Lampblack—Machinery for Colour Grinding and Rubbing—Machines for mixing Pigments with the Vehicle—Paint Mills—Manufacture of House Oil Paints—Ship Paints—Luminous Paint—Artists' Colours—Printers' Inks:—VEHICLES—Printers' Inks:—PIGMENTS and MANUFACTURE—Index.

(*See also Writing Inks, p.* 11.)

SIMPLE METHODS FOR TESTING PAINTERS' MATERIALS. By A. C. Wright, M.A. (Oxon.), B.Sc. (Lond.). Crown 8vo. 160 pp. 1903. Price 5s.; India and British Colonies, 5s. 6d.; Other Countries, 6s.; strictly Net.

Contents.

Necessity for Testing—Standards—Arrangement—The Apparatus—The Reagents—Practical Tests—Dry Colours—Stiff Paints—Liquid and Enamel Paints—Oil Varnishes—Spirit Varnishes—Driers—Putty—Linseed Oil—Turpentine—Water Stains—The Chemical Examination—Dry Colours and Paints—White Pigments and Paints—Yellow Pigments and Paints—Blue Pigments and Paints—Green Pigments and Paints—Red Pigments and Paints—Brown Pigments and Paints—Black Pigments and Paints—Oil Varnishes—Linseed Oil—Turpentine.

IRON-CORROSION, ANTI-FOULING AND ANTI-CORROSIVE PAINTS. Translated from the German of Louis Edgar Andés. Sixty-two Illustrations. 275 pp. Demy 8vo. 1900. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Iron-rust and its Formation—Protection from Rusting by Paint—Grounding the Iron with Linseed Oil, etc.—Testing Paints—Use of Tar for Painting on Iron—Anti-corrosive Paints—Linseed Varnish—Chinese Wood Oil—Lead Pigments—Iron Pigments—Artificial Iron Oxides—Carbon—Preparation of Anti-corrosive Paints—Results of Examination of Several Anti-corrosive Paints—Paints for Ship's Bottoms—Anti-fouling Compositions—Various Anti-corrosive and Ship's Paints—Official Standard Specifications for Ironwork Paints—Index.

THE TESTING AND VALUATION OF RAW MATERIALS USED IN PAINT AND COLOUR MANUFACTURE. By M. W. Jones, F.C.S. A Book for the Laboratories of Colour Works. 88 pp. Crown 8vo. 1900. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Aluminium Compounds—China Clay—Iron Compounds—Potassium Compounds—Sodium Compounds—Ammonium Hydrate—Acids—Chromium Compounds—Tin Compounds—Copper Compounds—Lead Compounds—Zinc Compounds—Manganese Compounds—Arsenic Compounds—Antimony Compounds—Calcium Compounds—Barium Compounds—Cadmium Compounds—Mercury Compounds—Ultramarine—Cobalt and Carbon Compounds—Oils Index.

STUDENTS' MANUAL OF PAINTS, COLOURS, OILS AND VARNISHES. By John Furnell. Crown 8vo. 10 Illustrations. [*In the Press.*

Contents.

Plant—Chromes—Blues—Greens—Earth Colours—Blacks—Reds—Lakes—Whites—Painters' Oils—Turpentine—Oil Varnishes—Spirit Varnishes—Liquid Paints—Enamel Paints.

Varnishes and Drying Oils.

THE MANUFACTURE OF VARNISHES, OIL REFINING AND BOILING, AND KINDRED INDUSTRIES. Translated from the French of Ach. Livache, Ingénieur Civil des Mines. Greatly Extended and Adapted to English Practice, with numerous Original Recipes by John Geddes McIntosh. 27 Illustrations. 400 pp. Demy 8vo. 1899. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

Resins—Solvents: Natural, Artificial, Manufacture, Storage, Special Use—Colouring Principles, Vegetable, Coal Tar, Coloured Resinates, Coloured Oleates and Linoleates—Gum Running: Melting Pots, Mixing Pans—Spirit Varnish Manufacture: Cold Solution Plant, Mechanical Agitators, Storage Plant—Manufacture, Characteristics and Uses of the Spirit Varnishes—Manufacture of Varnish Stains—Manufacture of Lacquers—Manufacture of Spirit Enamels—Analysis of Spirit Varnishes—Physical and Chemical Constants of Resins—Table of Solubility of Resins in different Menstrua—Systematic qualitative Analysis of Resins, Hirschop's tables—Drying Oils—Oil Refining: Processes—Oil Boiling—Driers—Liquid Driers — Solidified Boiled Oil — Manufacture of Linoleum — Manufacture of India Rubber Substitutes—Printing Ink Manufacture—Lithographic Ink Manufacture—Manufacture of Oil Varnishes—Running and Special Treatment of Amber, Copal, Kauri, Manilla—Addition of Oil to Resin—Addition of Resin to Oil—Mixed Processes—Solution in Cold of previously Fused Resin—Dissolving Resins in Oil, etc., under pressure—Filtration—Clarification—Storage—Ageing—Coachmakers' Varnishes and Japans—Oak Varnishes—Japanners' Stoving Varnishes—Japanners' Gold Size—Brunswick Black—Various Oil Varnishes—Oil-Varnish Stains—Varnishes for "Enamels"—India Rubber Varnishes—Varnishes Analysis: Processes, Matching—Faults in Varnishes: Cause, Prevention—Experiments and Exercises.

DRYING OILS, BOILED OIL AND SOLID AND LIQUID DRIERS. By L. E. Andés. Expressly Written for this Series of Special Technical Books, and the Publishers hold the Copyright for English and Foreign Editions. Forty-two Illustrations. 342 pp. 1901. Demy 8vo. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

Properties of the Drying Oils; Cause of the Drying Property; Absorption of Oxygen; Behaviour towards Metallic Oxides, etc.—The Properties of and Methods for obtaining the Drying Oils—Production of the Drying Oils by Expression and Extraction; Refining and Bleaching; Oil Cakes and Meal; The Refining and Bleaching of the Drying Oils; The Bleaching of Linseed Oil—The Manufacture of Boiled Oil; The Preparation of Drying Oils for Use in the Grinding of Paints and Artists' Colours and in the Manufacture of Varnishes by Heating over a Fire or by Steam, by the Cold Process, by the Action of Air, and by Means of the Electric Current; The Driers used in Boiling Linseed Oil; The Manufacture of Boiled Oil and the Apparatus therefor; Livache's Process for Preparing a Good Drying Oil and its Practical Application—The Preparation of Varnishes for Letterpress, Lithographic and Copperplate Printing, for Oilcloth and Waterproof Fabrics; The Manufacture of Thickened Linseed Oil, Burnt Oil, Stand Oil by Fire Heat, Superheated Steam, and by a Current of Air—Behaviour of the Drying Oils and Boiled Oils towards Atmospheric Influences, Water, Acids and Alkalies—Boiled Oil Substitutes—The Manufacture of Solid and Liquid Driers from Linseed Oil and Rosin; Linolic Acid Compounds of the Driers—The Adulteration and Examination of the Drying Oils and Boiled Oil.

Oils, Fats, Soaps and Perfumes.

LUBRICATING OILS, FATS AND GREASES: Their Origin, Preparation, Properties, Uses and Analyses. A Handbook for Oil Manufacturers, Refiners and Merchants, and the Oil and Fat Industry in General. By George H. Hurst, F.C.S. Second Revised and Enlarged Edition. Sixty-five Illustrations. 317 pp. Demy 8vo. 1902. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Introductory. Oils and Fats, Fatty Oils and Fats, Hydrocarbon Oils, Uses of Oils—**Hydrocarbon Oils.** Distillation, Simple Distillation, Destructive Distillation, Products of Distillation, Hydrocarbons, Paraffins, Olefins, Napthenes—**Scotch Shale Oils.** Scotch Shales, Distillation of Scotch Oils, Shale Retorts, Products of Distilling Shales, Separating Products, Treating Crude Shale Oil, Refining Shale Oil, Shale Oil Stills, Shale Naphtha Burning Oils, Lubricating Oils, Wax—**Petroleum.** Occurrence, Geology, Origin, Composition, Extraction, Refining, Petroleum Stills, Petroleum Products, Cylinder Oils, Russian Petroleum, Deblooming Mineral Oils—**Vegetable and Animal Oils.** Introduction, Chemical Composition of Oils and Fats, Fatty Acids, Glycerine, Extraction of Animal and Vegetable Fats and Oils, Animal Oils, Vegetable Oils. Rendering, Pressing, Refining, Bleaching, Tallow,

Tallow Oil, Lard Oil, Neatsfoot Oil, Palm Oil, Palm Nut Oil, Cocoanut Oil, Castor Oil, Olive Oil, Rape and Colza Oils, Arachis Oil, Niger Seed Oil, Sperm Oils, Whale Oil, Seal Oil, Brown Oils, Lardine, Thickened Rape Oil—**Testing and Adulteration of Oils.** Specific Gravity, Alkali Tests, Sulphuric Acid Tests, Free Acids in Oils, Viscosity Tests, Flash and Fire Tests, Evaporation Tests, Iodine and Bromide Tests, Elaidin Test, Melting Point of Fat, Testing Machines—**Lubricating Greases.** Rosin Oil, Anthracene Oil, Making Greases, Testing and Analysis of Greases—**Lubrication.** Friction and Lubrication, Lubricant, Lubrication of Ordinary Machinery, Spontaneous Combustion of Oils, Stainless Oils, Lubrication of Engine Cylinders, Cylinder Oils—**Appendices.** A. Table of Baume's Hydrometer—B. Table of Thermometric Degrees—C. Table of Specific Gravities of Oils—**Index**

TECHNOLOGY OF PETROLEUM: Oil Fields of the World—Their History, Geography and Geology—Annual Production and Development—Oil-well Drilling—Transport. By HENRY NEUBERGER and HENRY NOALHAT. Translated from the French by J. G. McINTOSH. 550 pp. 153 Illustrations. 26 Plates. Super Royal 8vo. 1901. Price 21s.; India and Colonies, 22s.; Other Countries, 23s. 6d.; strictly net.

Contents.

Study of the Petroliferous Strata—Petroleum—Definition—The Genesis or Origin of Petroleum—The Oil Fields of Galicia, their History—Physical Geography and Geology of the Galician Oil Fields—Practical Notes on Galician Land Law—Economic Hints on Working, etc.—Roumania—History, Geography, Geology—Petroleum in Russia—History—Russian Petroleum (*continued*)—Geography and Geology of the Caucasian Oil Fields—Russian Petroleum (*continued*)—The Secondary Oil Fields of Europe, Northern Germany, Alsace, Italy, etc.—Petroleum in France—Petroleum in Asia—Transcaspian and Turkestan Territory—Turkestan—Persia—British India and Burmah—British Burmah or Lower Burmah—China—Chinese Thibet—Japan, Formosa and Saghalien—Petroleum in Oceania—Sumatra, Java, Borneo—Isle of Timor—Philippine Isles—New Zealand—The United States of America—History—Physical Geology and Geography of the United States Oil Fields—Canadian and other North American Oil Fields—Economic Data of Work in North America—Petroleum in the West Indies and South America—Petroleum in the French Colonies.

Excavations—Hand Excavation or Hand Digging of Oil Wells.

Methods of Boring—Methods of Oil-well Drilling or Boring—Boring Oil Wells with the Rope—Drilling with Rigid Rods and a Free-fall—Fabian System—Free-fall Drilling by Steam Power—Oil-well Drilling by the Canadian System—Drilling Oil Wells on the Combined System—Comparison between the Combined Fauck System and the Canadian—The American System of Drilling with the Rope—Hydraulic Boring with the Drill by Hand and Steam Power—Rotary Drilling of Oil Wells, Bits, Steel-crowned Tools, Diamond Tools—Hand Power and Steam Power—Hydraulic Sand-pumping—Improvements in and different Systems of Drilling Oil Wells.

Accidents—Boring Accidents—Methods of preventing them—Methods of remedying them—Explosives and the use of the "Torpedo" Levigation—Storing and Transport of Petroleum—General Advice—Prospecting, Management and carrying on of Petroleum Boring Operations.

General Data—Customary Formulæ—Memento. Practical Part. General Data bearing on Petroleum—Glossary of Technical Terms used in the Petroleum Industry—Copious Index.

THE PRACTICAL COMPOUNDING OF OILS, TALLOW AND GREASE FOR LUBRICATION, ETC. By AN EXPERT OIL REFINER. 100 pp. 1898. Demy 8vo. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Introductory Remarks on the General Nomenclature of Oils, Tallow and Greases suitable for Lubrication—**Hydrocarbon Oils—Animal and Fish Oils—Compound Oils—Vegetable Oils—Lamp Oils—Engine Tallow, Solidified Oils and Petroleum Jelly—Machinery Greases: Loco and Anti-friction—Clarifying and Utilisation of Waste Fats, Oils, Tank Bottoms, Drainings of Barrels and Drums, Pickings Up, Dregs, etc.—The Fixing and Cleaning of Oil Tanks, etc.—Appendix and General Information.**

ANIMAL FATS AND OILS: Their Practical Production, Purification and Uses for a great Variety of Purposes. Their Properties, Falsification and Examination. Translated from the German of LOUIS EDGAR ANDÉS. Sixty-two Illustrations. 240 pp. 1898. Demy 8vo. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Introduction—Occurrence, Origin, Properties and Chemical Constitution of Animal Fats—Preparation of Animal Fats and Oils—Machinery—Tallow-melting Plant—Extraction Plant—Presses—Filtering Apparatus—Butter: Raw Material and Preparation, Properties, Adulterations, Beef Lard or Remelted Butter, Testing—Candle-fish Oil—Mutton-Tallow—Hare Fat—Goose Fat—Neatsfoot Oil—Bone Fat: Bone Boiling, Steaming Bones, Extraction, Refining—Bone Oil—Artificial Butter: Oleomargarine, Margarine Manufacture in France, Grasso's Process, "Kaiser's Butter," Jahr & Münzberg's Method, Filbert's Process, Winter's Method—Human Fat—Horse Fat—Beef Marrow—Turtle Oil—Hog's Lard: Raw Material—Preparation, Properties, Adulterations, Examination—Lard Oil—Fish Oils—Liver Oils—Artificial Train Oil—Wool Fat: Properties, Purified Wool Fat—Spermaceti: Examination of Fats and Oils in General.

VEGETABLE FATS AND OILS: Their Practical Preparation, Purification and Employment for Various Purposes, their Properties, Adulteration and Examination. Translated from the German of LOUIS EDGAR ANDÉS. Ninety-four Illustrations. 340 pp. Second Edition. 1902. Demy 8vo. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

General Properties—Estimation of the Amount of Oil in Seeds—The Preparation of Vegetable Fats and Oils—Apparatus for Grinding Oil Seeds and Fruits—**Installation of Oil and Fat Works**—Extraction Method of Obtaining Oils and Fats—Oil Extraction Installations—Press Moulds—**Non-drying Vegetable Oils—Vegetable drying Oils—Solid Vegetable Fats**—Fruits Yielding Oils and Fats—Wool-softening Oils—Soluble Oils—Treatment of the Oil after Leaving the Press—Improved Methods of Refining—**Bleaching Fats and Oils**—Practical Experiments on the Treatment of Oils with regard to Refining and Bleaching—Testing Oils and Fats.

SOAPS. A Practical Manual of the Manufacture of Domestic, Toilet and other Soaps. By GEORGE H. HURST, F.C.S. 390 pp. 66 Illustrations. 1898. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

Introductory—Soap-maker's Alkalies—Soap Fats and Oils—Perfumes—Water as a Soap Material—Soap Machinery—Technology of Soap-making—Glycerine in Soap Lyes—Laying out a Soap Factory—Soap Analysis—Appendices.

THE CHEMISTRY OF ESSENTIAL OILS AND ARTIFICIAL PERFUMES. By ERNEST J. PARRY, B.Sc. (Lond.), F.I.C., F.C.S. 411 pp. 20 Illustrations. 1899. Demy 8vo. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

The General Properties of Essential Oils—Compounds occurring in Essential Oils—The Preparation of Essential Oils—The Analysis of Essential Oils—Systematic Study of the Essential Oils—Terpeneless Oils—The Chemistry of Artificial Perfumes—Appendix: Table of Constants—**Index.**

Cosmetical Preparations.

COSMETICS: MANUFACTURE, EMPLOYMENT AND TESTING OF ALL COSMETIC MATERIALS AND COSMETIC SPECIALITIES. Translated from the German of Dr. THEODOR KOLLER. Crown 8vo. 262 pp. 1902. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s. net.

Contents.

Purposes and Uses of, and Ingredients used in the Preparation of Cosmetics—Preparation of Perfumes by Pressure, Distillation, Maceration, Absorption or Enfleurage, and Extraction Methods—Chemical and Animal Products used in the Preparation of Cosmetics—Oils and Fats used in the Preparation of Cosmetics—General Cosmetic Preparations—Mouth Washes and Tooth Pastes—Hair Dyes, Hair Restorers and Depilatories—Cosmetic Adjuncts and Specialities—Colouring Cosmetic Preparations—Antiseptic Washes and Soaps—Toilet and Hygienic Soaps—Secret Preparations for Skin, Complexion, Teeth, Mouth, etc.—Testing and Examining the Materials Employed in the Manufacture of Cosmetics—Index.

Glue, Bone Products and Manures.

GLUE AND GLUE TESTING. By SAMUEL RIDEAL, D.Sc. (Lond.), F.I.C. Fourteen Engravings. 144 pp. Demy 8vo. 1900. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Constitution and Properties: Definitions and Sources, Gelatine, Chondrin and Allied Bodies, Physical and Chemical Properties, Classification, Grades and Commercial Varieties—**Raw Materials and Manufacture:** Glue Stock, Lining, Extraction, Washing and Clarifying, Filter Presses, Water Supply, Use of Alkalies, Action of Bacteria and of Antiseptics, Various Processes, Cleansing, Forming, Drying, Crushing, etc., Secondary Products—**Uses of Glue:** Selection and Preparation for Use, Carpentry, Veneering, Paper-Making, Bookbinding, Printing Rollers, Hectographs, Match Manufacture, Sandpaper, etc., Substitutes for other Materials, Artificial Leather and Caoutchouc—**Gelatine:** General Characters, Liquid Gelatine, Photographic Uses, Size, Tanno-, Chrome and Formo-Gelatine, Artificial Silk, Cements, Pneumatic Tyres, Culinary, Meat Extracts, Isinglass, Medicinal and other Uses, Bacteriology—**Glue Testing:** Review of Processes, Chemical Examination, Adulteration, Physical Tests, Valuation of Raw Materials—**Commercial Aspects.**

BONE PRODUCTS AND MANURES: An Account of the most recent Improvements in the Manufacture of Fat, Glue, Animal Charcoal, Size, Gelatine and Manures. By THOMAS LAMBERT, Technical and Consulting Chemist. Illustrated by Twenty-one Plans and Diagrams. 162 pp. Demy 8vo. 1901. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Chemical Composition of Bones—Arrangement of Factory—Crushing of Bones—Treatment with Benzene—Benzene in Crude Fat—Analyses of Clarified Fats—Mechanical Cleansing of Bones—Animal Charcoal—Tar and Ammoniacal Liquor, Char and Gases, from good quality Bones—Method of Retorting the Bones—Analyses of Chars—"Spent" Chars—Cooling of Tar and Ammoniacal Vapours—Value of Nitrogen for Cyanide of Potash—Bone Oil—Marrow Bones—Composition of Marrow Fat—Premier Juice—Buttons—Properties of Glue—Glutin and Chondrin—Skin Glue—Liming of Skins—Washing—Boiling of Skins—Clarification of Glue Liquors—Acid Steeping of Bones—Water System of Boiling Bones—Steam Method of Treating Bones—Nitrogen in the Treated Bones—Glue-Boiling and Clarifying-House—Plan showing Arrangement of Clarifying Vats—Plan showing Position of Evaporators—Description of Evaporators—Sulphurous Acid Generator—Clarification of Liquors—Section of Drying-House—Specification of a Glue—Size—Uses and Preparation and Composition of Size—Concentrated Size—Properties of Gelatine—Preparation of Skin Gelatine—Washing—Bleaching—Boiling—Clarification—Evaporation—Drying—Bone Gelatine—Selecting Bones—Crushing—Dissolving—Bleaching—Boiling—Properties of Glutin and Chondrin—Testing of Glues and Gelatines—The Uses of Glue, Gelatine and Size in Various Trades—Soluble and Liquid Glues—Steam and Waterproof Glues—**Manures**—Importation of Food Stuffs—Soils—Germination—Plant Life—**Natural Manures**—Water and Nitrogen in Farmyard Manure—Full Analysis of Farmyard Manure—Action on Crops—Water-Closet System—Sewage Manure—Green Manures—**Artificial Manures**—**Mineral Manures**—Nitrogenous Matters—Shoddy—Hoofs and Horns—Leather Waste—Dried Meat—Dried Blood—Superphosphates—Composition—Manufacture—Section of Manure-Shed—First and Ground Floor Plans of Manure-Shed—Quality of Acid Used—Mixings—Special Manures—Potato Manure—Dissolved Bones—Dissolved Bone Compound—Enriched Peruvian Guano—Special Manure for Garden Stuffs, etc.—Special Manures—Analyses of Raw and Finished Products—Common Raw Bones—Degreased Bones—Crude Fat—Refined Fat—Degelatinised Bones—Animal Charcoal—Bone Superphosphates—Guanos—Dried Animal Products—Potash Compounds—Sulphate of Ammonia—Extraction in Vacuo—French and British Gelatines compared—Index.

Chemicals, Waste Products and Agricultural Chemistry.

REISSUE OF **CHEMICAL ESSAYS OF C. W. SCHEELE.** First Published in English in 1786. Translated from the Academy of Sciences at Stockholm, with Additions. 300 pp. Demy 8vo. 1901. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Memoir: C. W. Scheele and his work (written for this edition by J. G. McIntosh)—On Fluor Mineral and its Acid—On Fluor Mineral—Chemical Investigation of Fluor Acid, with a View to the Earth which it Yields, by Mr. Wiegler—Additional Information Concerning Fluor Minerals—On Manganese, Magnesium, or Magnesia Vitrariorum—On Arsenic and its Acid—Remarks upon Salts of Benzoin—On Silex, Clay and Alum—Analysis of the Calculus Vesical—Method of Preparing Mercurius Dulcis Via Humida—Cheaper and more Convenient Method of Preparing Pulvis Algarothi—Experiments upon Molybdæna—Experiments on Plumbago—Method of Preparing a New Green Colour—Of the Decomposition of Neutral Salts by Unslaked Lime and Iron—On the Quantity of Pure Air which is Daily Present in our Atmosphere—On Milk and its Acid—On the Acid of Saccharum Lactis—On the Constituent Parts of Lapis Ponderosus or Tungsten—Experiments and Observations on Ether—Index.

THE MANUFACTURE OF ALUM AND THE SULPHATES AND OTHER SALTS OF ALUMINA AND IRON. Their Uses and Applications as Mordants in Dyeing and Calico Printing, and their other Applications in the Arts, Manufactures, Sanitary Engineering, Agriculture and Horticulture. Translated from the French of LUCIEN GESCHWIND. 195 Illustrations. 400 pp. Royal 8vo. 1901. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

Theoretical Study of Aluminium, Iron, and Compounds of these Metals—Aluminium and its Compounds—Iron and Iron Compounds.

Manufacture of Aluminium Sulphates and Sulphates of Iron—Manufacture of Aluminium Sulphate and the Alums—Manufacture of Sulphates of Iron.

Uses of the Sulphates of Aluminium and Iron—Uses of Aluminium Sulphate and Alums—Application to Wool and Silk—Preparing and using Aluminium Acetates—Employment of Aluminium Sulphate in Carbonising Wool—The Manufacture of Lake Pigments—Manufacture of Prussian Blue—Hide and Leather Industry—Paper Making—Hardening Plaster—Lime Washes—Preparation of Non-inflammable Wood, etc.—Purification of Waste Waters—**Uses and Applications of Ferrous Sulphate and Ferric Sulphates**—Dyeing—Manufacture of Pigments—Writing Inks—Purification of Lighting Gas—Agriculture—Cotton Dyeing—Disinfectant—Purifying Waste Liquors—Manufacture of Nordhausen Sulphuric Acid—Fertilising.

Chemical Characteristics of Iron and Aluminium—Analysis of Various Aluminous or Ferruginous Products—Aluminium—**Analysing Aluminium Products**—Alunite Alumina—Sodium Aluminate—Aluminium Sulphate—**Iron**—Analytical Characteristics of Iron Salts—Analysis of Pyritic Lignite—Ferrous and Ferric Sulphates—Rouil Mordant—Index.

AMMONIA AND ITS COMPOUNDS: Their Manufacture and Uses. By CAMILLE VINCENT, Professor at the Central School of Arts and Manufactures, Paris. Translated from the French by M. J. SALTER. Royal 8vo. 114 pp. 1901. Thirty-two Illustrations. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

General Considerations: Various Sources of Ammoniacal Products; Human Urine as a Source of Ammonia—**Extraction of Ammoniacal Products from Sewage—Extraction of Ammonia from Gas Liquor—Manufacture of Ammoniacal Compounds from Bones, Nitrogenous Waste, Beetroot Wash and Peat—Manufacture of Caustic Ammonia, and Ammonium Chloride, Phosphate and Carbonate—Recovery of Ammonia from the Ammonia-Soda Mother Liquors—Index.**

ANALYSIS OF RESINS AND BALSAMS. Translated from the German of Dr. KARL DIETERICH. Demy 8vo. 340 pp. 1901. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Definition of Resins in General—Definition of Balsams, and especially the Gum Resins—External and Superficial Characteristics of Resinous Bodies—Distinction between Resinous Bodies and Fats and Oils—Origin, Occurrence and Collection of Resinous Substances—Classification—Chemical Constituents of Resinous Substances—Resinols—Resinot Annols—Behaviour of Resin Constituents towards the Cholesterine Reactions—Uses and Identification of Resins—Melting-point—Solvents—Acid Value—Saponification Value—Resin Value—Ester and Ether Values—Acetyl and Corbonyl Value—Methyl Value—Resin Acid—Systematic Résumé of the Performance of the Acid and Saponification Value Tests.

Balsams—Introduction—Definitions—Canada Balsam—Copaiba Balsam—Angostura Copaiba Balsam—Babia Copaiba Balsam—Carthagena Copaiba Balsam—Maracaibo Copaiba Balsam—Maturin Copaiba Balsam—Gurjum Copaiba Balsam—Para Copaiba Balsam—Surinam Copaiba Balsam—West African Copaiba Balsam—Mecca Balsam—Peruvian Balsam—Tolu Balsam—Acaroid Resin—Amine—Amber—African and West Indian Kino—Bengal Kino—Labdanum—Mastic—Pine Resin—Sandarach—Scammonium—Shellac—Storax—Adulteration of Styrax Liquidus Crudus—Purified Storax—Styrax Crudus Colatus—Tacamahac—Thapsia Resin—Turpentine—Chios Turpentine—Strassburg Turpentine—Turpeth Turpentine. **Gum Resins**—Ammoniacum—Bdellium—Euphorbium—Galbanum—Gamboge—Lactucarium—Myrrh—Opopanax—Sagapenum—Olibanum or Incense—Acaroid Resin—Amber—Thapsia Resin—Index.

MANUAL OF AGRICULTURAL CHEMISTRY. By HERBERT INGLE, F.I.C., Lecturer on Agricultural Chemistry, the Yorkshire College; Lecturer in the Victoria University. 388 pp. 11 Illustrations. 1902. Demy 8vo. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d. net.

Contents.

Introduction—The Atmosphere—The Soil—The Reactions occurring in Soils—The Analysis of Soils—Manures, Natural—Manures (continued)—The Analysis of Manures—The Constituents of Plants—The Plant—Crops—The Animal—Foods and Feeding—Milk and Milk Products—The Analysis of Milk and Milk Products—Miscellaneous Products used in Agriculture—Appendix—Index.

THE UTILISATION OF WASTE PRODUCTS. A Treatise on the Rational Utilisation, Recovery and Treatment of Waste Products of all kinds. By Dr. THEODOR KOLLER. Translated from the Second Revised German Edition. Twenty-two Illustrations. Demy 8vo. 280 pp. 1902. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

The Waste of Towns—**Ammonia and Sal-Ammoniac**—Rational Processes for Obtaining these Substances by Treating Residues and Waste—Residues in the Manufacture of Aniline Dyes—Amber Waste—Brewers' Waste—Blood and Slaughter-House Refuse—Manufactured Fuels—Waste Paper and Bookbinders' Waste—Iron Slags—Excrement—Colouring Matters from Waste—Dyers' Waste Waters—Fat from Waste—Fish Waste—Calamine Sludge—Tannery Waste—Gold and Silver Waste—India-rubber and Caoutchouc Waste—Residues in the Manufacture of Rosin Oil—Wood Waste—Horn Waste—Infusorial Earth—Iridium from Goldsmiths' Sweepings—Jute Waste—Cork Waste—Leather Waste—Glue Makers' Waste—Illuminating Gas from Waste and the By-Products of the Manufacture of Coal Gas—Meerschum—Molasses—Metal Waste—By-Products in the Manufacture of Mineral Waters—Fruit—The By-Products of Paper and Paper Pulp Works—By-Products in the Treatment of Coal Tar Oils—Fur Waste—The Waste Matter in the Manufacture of Parchment Paper—Mother of Pearl Waste—Petroleum Residues—Platinum Residues—Broken Porcelain. Earthenware and Glass—Salt Waste—Slate Waste—Sulphur—Burnt Pyrites—Silk Waste—Soap Makers' Waste—Alkali Waste and the Recovery of Soda—Waste Produced in Grinding Mirrors—Waste Products in the Manufacture of Starch—Stearic Acid—Vegetable Ivory Waste—Turf—Waste Waters of Cloth Factories—Wine Residues—Tinplate Waste—Wool Waste—Wool Sweat—The Waste Liquids from Sugar Works—Index.

Writing Inks and Sealing Waxes.

INK MANUFACTURE: Including Writing, Copying, Lithographic, Marking, Stamping, and Laundry Inks. By SIGMUND LEHNER. Three Illustrations. Crown 8vo. 162 pp. 1902. Translated from the German of the Fifth Edition. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; net.

Contents.

Varieties of Ink—Writing Inks—Raw Materials of Tannin Inks—The Chemical Constitution of the Tannin Inks—Recipes for Tannin Inks—Logwood Tannin Inks—Ferric Inks—Alizarine Inks—Extract Inks—Logwood Inks—Copying Inks—Hektographs—Hektograph Inks—Safety Inks—Ink Extracts and Powders—Preserving Inks—Changes in Ink and the Restoration of Faded Writing—Coloured Inks—Red Inks—Blue Inks—Violet Inks—Yellow Inks—Green Inks—Metallic Inks—Indian Ink—Lithographic Inks and Pencils—Ink Pencils—Marking Inks—Ink Specialities—Sympathetic Inks—Stamping Inks—Laundry or Washing Blue—Index.

SEALING-WAXES, WAFERS AND OTHER ADHESIVES FOR THE HOUSEHOLD, OFFICE, WORKSHOP AND FACTORY. By H. C. STANDAGE. Crown 8vo. 96 pp. 1902. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Materials Used for Making Sealing-Waxes—The Manufacture of Sealing-Waxes—Wafers—Notes on the Nature of the Materials Used in Making Adhesive Compounds—Cements for Use in the Household—Office Gums, Pastes and Mucilages—Adhesive Compounds for Factory and Workshop Use.

Lead Ores and Compounds.

LEAD AND ITS COMPOUNDS. By THOS. LAMBERT, Technical and Consulting Chemist. Demy 8vo. 226 pp. Forty Illustrations. 1902. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; net. Plans and Diagrams.

Contents.

History—Ores of Lead—Geographical Distribution of the Lead Industry—Chemical and Physical Properties of Lead—Alloys of Lead—Compounds of Lead—Dressing of Lead Ores—Smelting of Lead Ores—Smelting in the Scotch or American Ore-hearth—Smelting in the Shaft or Blast Furnace—Condensation of Lead Fume—Desilverisation, or the Separation of Silver from Argentiferous Lead—Cupellation—The Manufacture of Lead Pipes and Sheets—Protoxide of Lead—Litharge and Massicot—Red Lead or Minium—Lead Poisoning—Lead Substitutes—Zinc and its Compounds—Pumice Stone—Drying Oils and Siccatives—Oil of Turpentine Resin—Classification of Mineral Pigments—Analysis of Raw and Finished Products—Tables—Index.

NOTES ON LEAD ORES: Their Distribution and Properties. By JAS. FAIRIE, F.G.S. Crown 8vo. 1901. 64 pages. Price 2s. 6d.; Abroad, 3s.; strictly net.

Industrial Uses of Air, Steam and Water.

DRYING BY MEANS OF AIR AND STEAM. Explanations, Formulæ, and Tables for Use in Practice. Translated from the German of E. HAUSBRAND. Two folding Diagrams and Thirteen Tables. Crown 8vo. 1901. 72 pp. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

British and Metric Systems Compared—Centigrade and Fahr. Thermometers—Estimation of the Maximum Weight of Saturated Aqueous Vapour which can be contained in 1 kilo. of Air at Different Pressure and Temperatures—Calculation of the Necessary Weight and Volume of Air, and of the Least Expenditure of Heat, per Drying Apparatus with Heated Air, at the Atmospheric Pressure: *A*, With the Assumption that the Air is *Completely Saturated* with Vapour both before Entry and after Exit from the Apparatus—*B*, When the Atmospheric Air is Completely Saturated *before entry*, but at its *exit* is *only* ¾, ½ or ¼ Saturated—*C*, When the Atmospheric Air is *not* Saturated with Moisture before Entering the Drying Apparatus—Drying Apparatus, in which, in the Drying Chamber, a Pressure is Artificially Created, Higher or Lower than that of the Atmosphere—Drying by Means of Superheated Steam, without Air—Heating Surface, Velocity of the Air Current, Dimensions of the Drying Room, Surface of the Drying Material, Losses of Heat—Index.

(See also "Evaporating, Condensing and Cooling Apparatus," p. 26.)

PURE AIR, OZONE AND WATER. A Practical Treatise of their Utilisation and Value in Oil, Grease, Soap, Paint, Glue and other Industries. By W. B. COWELL. Twelve Illustrations. Crown 8vo. 85 pp. 1900. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Atmospheric Air; Lifting of Liquids; Suction Process; Preparing Blown Oils; Preparing Siccative Drying Oils—Compressed Air; Whitewash—Liquid Air; Retrocession—Purification of Water; Water Hardness—Fleshings and Bones—Ozonised Air in the Bleaching and Deodorising of Fats, Glues, etc.; Bleaching Textile Fibres—Appendix: Air and Gases; Pressure of Air at Various Temperatures; Fuel; Table of Combustibles; Saving of Fuel by Heating Feed Water; Table of Solubilities of Scale Making Minerals; British Thermal Units Tables; Volume of the Flow of Steam into the Atmosphere; Temperature of Steam—Index.

THE INDUSTRIAL USES OF WATER. COMPOSITION — EFFECTS—TROUBLES — REMEDIES—RESIDUARY WATERS—PURIFICATION—ANALYSIS. By H. DE LA COUX. Royal 8vo. 400 pp. 135 Illustrations. Translated from the French. [*In the press.*

Contents.

Chemical Action of Water in Nature and in Industrial Use—Composition of Waters—Solubility of Certain Salts in Water Considered from the Industrial Point of View—Effects on the Boiling of Water—Effects of Water in the Industries—Difficulties with Water—Feed Water for Boilers—Water in Dyeworks, Print Works, and Bleach Works—Water in the Textile Industries and in Conditioning—Water in Soap Works—Water in Laundries and Washhouses—Water in Tanning—Water in Preparing Tannin and Dyewood Extracts—Water in Papermaking—Water in Photography—Water in Sugar Refining—Water in Making Ices and Beverages—Water in Cider Making—Water in Brewing—Water in Distilling—Preliminary Treatment and Apparatus—Substances Used for Preliminary Chemical Purification—Commercial Specialities and their Employment—Precipitation of Matters in Suspension in Water—Apparatus for the Preliminary Chemical Purification of Water—Industrial Filters—Industrial Sterilisation of Water—Residuary Waters and their Purification—Soil Filtration—Purification by Chemical Processes—Analyses—Index.

(See Books on Smoke Prevention, Engineering and Metallurgy, p. 26, etc.)

Industrial Hygiene.

THE RISKS AND DANGERS TO HEALTH OF VARIOUS OCCUPATIONS AND THEIR PREVENTION. By LEONARD A. PARRY, M.D., B.S. (Lond.). 196 pp. Demy 8vo. 1900. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Occupations which are Accompanied by the Generation and Scattering of Abnormal Quantities of Dust—Trades in which there is Danger of Metallic Poisoning—Certain Chemical Trades—Some Miscellaneous Occupations—Trades in which Various Poisonous Vapours are Inhaled—General Hygienic Considerations—Index.

X Rays.

PRACTICAL X RAY WORK. By FRANK T. ADDYMAN, B.Sc. (Lond.), F.I.C., Member of the Roentgen Society of London; Radiographer to St. George's Hospital; Demonstrator of Physics and Chemistry, and Teacher of Radiography in St. George's Hospital Medical School. Demy 8vo. Twelve Plates from Photographs of X Ray Work. Fifty-two Illustrations. 200 pp. 1901. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Historical—Work leading up to the Discovery of the X Rays—The Discovery—**Apparatus and its Management**—Electrical Terms—Sources of Electricity—Induction Coils—Electrostatic Machines—Tubes—Air Pumps—Tube Holders and Stereoscopic Apparatus—Fluorescent Screens—**Practical X Ray Work**—Installations—Radioscopy—Radiography—X Rays in Dentistry—X Rays in Chemistry—X Rays in War—Index.

List of Plates.

Frontispiece—Congenital Dislocation of Hip-Joint.—I., Needle in Finger.—II., Needle in Foot.—III., Revolver Bullet in Calf and Leg.—IV., A Method of Localisation.—V., Stellate Fracture of Patella showing shadow of "Strapping".—VI., Sarcoma.—VII., Six-weeks-old Injury to Elbow showing new Growth of Bone.—VIII., Old Fracture of Tibia and Fibula badly set.—IX., Heart Shadow.—X., Fractured Femur showing Grain of Splint.—XI., Barrell's Method of Localisation.

India-Rubber and Gutta Percha.

INDIA-RUBBER AND GUTTA PERCHA. Translated from the French of T. SEELIGMANN, G. LAMY TORVILHON and H. FALCONNET by JOHN GEDDES McINTOSH. Royal 8vo. Eighty-six Illustrations. Three Plates. 412 pages. 1903. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

India-Rubber—Botanical Origin—Climatology—Soil—Rational Culture and Acclimation of the Different Species of India-Rubber Plants—Methods of Obtaining the Latex—Methods of Preparing Raw or Crude India-Rubber—Classification of the Commercial Species of Raw Rubber—Physical and Chemical Properties of the Latex and of India-Rubber—Mechanical Transformation of Natural Caoutchouc into Washed or Normal Caoutchouc (Purification) and Normal Rubber into Masticated Rubber—Softening, Cutting, Washing, Drying—Preliminary Observations—Vulcanisation of Normal Rubber—Chemical and Physical Properties of Vulcanised Rubber—General Considerations—Hardened Rubber or Ebonite—Considerations on Mineralisation and other Mixtures—Coloration and Dyeing—Analysis of Natural or Normal Rubber and Vulcanised Rubber—Rubber Substitutes—Imitation Rubber.

Gutta Percha—Botanical Origin—Climatology—Soil—Rational Culture—Methods of Collection—Classification of the Different Species of Commercial Gutta Percha—Physical and Chemical Properties—Mechanical Transformation—Methods of Analysing—Gutta Percha Substitutes—Index.

Leather Trades.

PRACTICAL TREATISE ON THE LEATHER INDUSTRY. By A. M. VILLON. Translated by FRANK T. ADDYMAN, B.Sc. (Lond.), F.I.C., F.C.S.; and Corrected by an Eminent Member of the Trade. 500 pp., royal 8vo. 1901. 123 Illustrations. Price 21s.; India and Colonies, 22s.; Other Countries, 23s. 6d.; strictly net.

Contents.

Preface—Translator's Preface—List of Illustrations.

Part I., **Materials used in Tanning**—Skins: Skin and its Structure; Skins used in Tanning; Various Skins and their Uses—Tannin and Tanning Substances: Tannin; Barks (Oak); Barks other than Oak; Tanning Woods; Tannin-bearing Leaves; Excrescences; Tan-bearing Fruits; Tan-bearing Roots and Bulbs; Tanning Juices; Tanning Substances used in Various Countries; Tannin Extracts; Estimation of Tannin and Tannin Principles.

Part II., **Tanning**—The Installation of a Tannary: Tan Furnaces; Chimneys, Boilers, etc.; Steam Engines—Grinding and Trituration of Tanning Substances: Cutting up Bark; Grinding Bark; The Grinding of Tan Woods; Powdering Fruit, Galls and Grains; Notes on

the Grinding of Bark—Manufacture of Sole Leather: Soaking; Sweating and Unhairing; Plumping and Colouring; Handling; Tanning; Tanning Elephants' Hides; Drying; Striking or Pinning—Manufacture of Dressing Leather: Soaking; Depilation; New Processes for the Depilation of Skins; Tanning; Cow Hides; Horse Hides; Goat Skins; Manufacture of Split Hides—On Various Methods of Tanning: Mechanical Methods; Physical Methods; Chemical Methods; Tanning with Extracts—Quantity and Quality; Quantity; Net Cost; Quality of Leather—Various Manipulations of Tanned Leather: Second Tanning; Grease Stains; Bleaching Leather; Waterproofing Leather; Weighting Tanned Leather; Preservation of Leather—Tanning Various Skins.

Part III., **Currying**—Waxed Calf: Preparation; Shaving; Stretching or Slicking; Oiling the Grain; Oiling the Flesh Side; Whitening and Graining; Waxing; Finishing; Dry Finishing; Finishing in Colour; Cost—White Calf: Finishing in White—Cow Hide for Upper Leathers: Black Cow Hide; White Cow Hide; Coloured Cow Hide—Smooth Cow Hide—Black Leather—Miscellaneous Hides: Horse; Goat; Waxed Goat Skin; Matt Goat Skin—Russia Leather: Russia Leather; Artificial Russia Leather.

Part IV., **Enamelled, Hungary and Chamoy Leather, Morocco, Parchment, Furs and Artificial Leather**—Enamelled Leather: Varnish Manufacture; Application of the Enamel; Enamelling in Colour—Hungary Leather: Preliminary; Wet Work or Preparation; Aluming; Dressing or Loft Work; Tallowing; Hungary Leather from Various Hides—Tawing: Preparatory Operations; Dressing; Dyeing Tawed Skins; Rugs—Chamoy Leather—Morocco: Preliminary Operations, Morocco Tanning; Mordants used in Morocco Manufacture; Natural Colours used in Morocco Dyeing; Artificial Colours; Different Methods of Dyeing; Dyeing with Natural Colours; Dyeing with Aniline Colours; Dyeing with Metallic Salts; Leather Printing; Finishing Morocco; Shagreen; Bronzed Leather—Gilding and Silvering: Gilding; Silvering; Nickel and Cobalt—Parchment—Furs and Furriery: Preliminary Remarks; Indigenous Furs; Foreign Furs from Hot Countries; Foreign Furs from Cold Countries; Furs from Birds' Skins; Preparation of Furs; Dressing; Colouring; Preparation of Birds' Skins; Preservation of Furs—Artificial Leather: Leather made from Scraps; Compressed Leather; American Cloth; Papier Mâché; Linoleum; Artificial Leather.

Part V., **Leather Testing and the Theory of Tanning**—Testing and Analysis of Leather: Physical Testing of Tanned Leather; Chemical Analysis—The Theory of Tanning and the other Operations of the Leather and Skin Industry: Theory of Soaking; Theory of Unhairing; Theory of Swelling; Theory of Handling; Theory of Tanning; Theory of the Action of Tannin on the Skin; Theory of Hungary Leather Making; Theory of Tawing; Theory of Chamoy Leather Making; Theory of Mineral Tanning.

Part VI., **Uses of Leather**—Machine Belts: Manufacture of Belting; Leather Chain Belts; Various Belts, Use of Belts—Boot and Shoe-making: Boots and Shoes; Laces—Saddlery: Composition of a Saddle; Construction of a Saddle—Harness: The Pack Saddle; Harness—Military Equipment—Glove Making—Carriage Building—Mechanical Uses.

Appendix, **The World's Commerce in Leather**—Europe; America; Asia; Africa; Australasia—Index.

THE LEATHER WORKER'S MANUAL. Being a Compendium of Practical Recipes and Working Formulæ for Curriers, Bootmakers, Leather Dressers, Blacking Manufacturers, Saddlers, Fancy Leather Workers. By H. C. STANDAGE. 165 pp. 1900. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Blackings, Polishes, Glosses, Dressings, Renovators, etc., for Boot and Shoe Leather—Harness Blackings, Dressings, Greases, Compositions, Soaps, and Boot-top Powders and Liquids, etc., etc.—Leather Grinders' Sundries—Currier's Seasonings, Blacking Compounds, Dressings, Finishes, Glosses, etc.—Dyes and Stains for Leather—Miscellaneous Information—Chrome Tannage—Index.

Books on Pottery, Bricks, Tiles, Glass, etc.

THE MANUAL OF PRACTICAL POTTING. Compiled by Experts, and Edited by CHAS. F. BINNS. Revised Third Edition and Enlarged. 200 pp. 1901. Price 17s. 6d.; India and Colonies, 18s. 6d.; Other Countries, 20s.; strictly net.

Contents.

Introduction. The Rise and Progress of the Potter's Art—**Bodies.** China and Porcelain Bodies, Parian Bodies, Semi-porcelain and Vitreous Bodies, Mortar Bodies, Earthenwares Granite and C.C. Bodies, Miscellaneous Bodies, Sagger and Crucible Clays, Coloured Bodies, Jasper Bodies, Coloured Bodies for Mosaic Painting, Encaustic Tile Bodies, Body

Stains, Coloured Dips—**Glazes.** China Glazes, Ironstone Glazes, Earthenware Glazes, Glazes without Lead, Miscellaneous Glazes, Coloured Glazes, Majolica Colours—**Gold and Gold Colours.** Gold, Purple of Cassius, Marone and Ruby, Enamel Coloured Bases, Enamel Colour Fluxes, Enamel Colours, Mixed Enamel Colours, Antique and Vellum Enamel Colours, Underglaze Colours, Underglaze Colour Fluxes, Mixed Underglaze Colours, Flow Powders, Oils and Varnishes—**Means and Methods.** Reclamation of Waste Gold, The Use of Cobalt, Notes on Enamel Colours, Liquid or Bright Gold—**Classification and Analysis.** Classification of Clay Ware, Lord Playfair's Analysis of Clays, The Markets of the World, Time and Scale of Firing, Weights of Potter's Material, Decorated Goods Count—Comparative Loss of Weight of Clays—Ground Felspar Calculations—The Conversion of Slop Body Recipes into Dry Weight—The Cost of Prepared Earthenware Clay—**Forms and Tables.** Articles of Apprenticeship, Manufacturer's Guide to Stocktaking, Table of Relative Values of Potter's Materials, Hourly Wages Table, Workman's Settling Table, Comparative Guide for Earthenware and China Manufacturers in the use of Slop Flint and Slop Stone, Foreign Terms applied to Earthenware and China Goods, Table for the Conversion of Metrical Weights and Measures on the Continent and South America—**Index.**

CERAMIC TECHNOLOGY: Being some Aspects of Technical Science as Applied to Pottery Manufacture. Edited by CHARLES F. BINNS. 100 pp. Demy 8vo. 1897. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

Preface—The Chemistry of Pottery — Analysis and Synthesis — Clays and their Components — The Biscuit Oven — Pyrometry — Glazes and their Composition — Colours and Colour-making—Index.

COLOURING AND DECORATION OF CERAMIC WARE. By ALEX. BRONGNIART. With Notes and Additions by ALPHONSE SALVETAT. Translated from the French. 200 pp. 1898. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d. strictly net.

A TREATISE ON THE CERAMIC INDUSTRIES. A Complete Manual for Pottery, Tile and Brick Works. By EMILE BOURRY. Translated from the French by WILTON P. RIX, Examiner in Pottery and Porcelain to the City and Guilds of London Technical Institute, Pottery Instructor to the Hanley School Board. Royal 8vo. 1901. Over 700 pp. Price 21s.; India and Colonies, 22s.; Other Countries, 23s. 6d.; strictly net.

Contents.

Part I., **General Pottery Methods.** Definition and History. Definitions and Classification of Ceramic Products—Historic Summary of the Ceramic Art—Raw Materials of Bodies. Clays: Pure Clay and Natural Clays—Various Raw Materials: Analogous to Clay—Agglomerative and Agglutinative—Opening—Fusible—Refractory—Trials of Raw Materials—Plastic Bodies. Properties and Composition—Preparation of Raw Materials: Disaggregation—Purification—Preparation of Bodies: By Plastic Method—By Dry Method—By Liquid Method—Formation. Processes of Formation: Throwing—Expression—Moulding by Hand, on the Jolley, by Compression, by Slip Casting—Slapping—Slipping—Drying. Drying of Bodies—Processes of Drying: By Evaporation—By Aeration—By Heating—By Ventilation—By Absorption — Glazes. Composition and Properties—Raw Materials — Manufacture and Application—Firing. Properties of the Bodies and Glazes during Firing—Description of the Kilns—Working of the Kilns — Decoration. Colouring Materials — Processes of Decoration.

Part II., **Special Pottery Methods.** Terra Cottas. Classification: Plain Ordinary, Hollow, Ornamental, Vitrified, and Light Bricks—Ordinary and Black Tiles—Paving Tiles—Pipes—Architectural Terra Cottas—Vases, Statues and Decorative Objects—Common Pottery—Pottery for Water and Filters—Tobacco Pipes—Lustre Ware—Properties and Tests for Terra Cottas — Fireclay Goods. Classification: Argillaceous, Aluminous, Carboniferous, Silicious and Basic Fireclay Goods—Fireclay Mortar (Pug)—Tests for Fireclay Goods—Faiences. Varnished Faiences—Enamelled Faiences—Silicious Faiences—Pipeclay Faiences—Pebble Work—Feldspathic Faiences—Composition, Processes of Manufacture and General Arrangements of Faience Potteries—Stoneware. Stoneware Properly So-called: Paving Tiles—Pipes—Sanitary Ware—Stoneware for Food Purposes and Chemical Productions—Architectural Stoneware—Vases, Statues and other Decorative Objects—Fine Stoneware—Porcelain. Hard Porcelain for Table Ware and Decoration, for the Fire, for Electrical Conduits, for Mechanical Purposes; Architectural Porcelain, and Dull or Biscuit Porcelain—Soft Phosphated or English Porcelain—Soft Vitreous Porcelain, French and New Sèvres—Argillaceous Soft or Seger's Porcelain—Dull Soft or Parian Porcelain—Dull Feldspathic Soft Porcelain—**Index.**

ARCHITECTURAL POTTERY. Bricks, Tiles, Pipes, Enamelled Terra-cottas, Ordinary and Incrusted Quarries, Stoneware Mosaics, Faïences and Architectural Stoneware. By LEON LEFÊVRE. With Five Plates. 950 Illustrations in the Text, and numerous estimates. 500 pp., royal 8vo. 1900. Translated from the French by K. H. BIRD, M.A., and W. MOORE BINNS. Price 15s.; India and Colonies, 16s.; Other Countries, 17s. 6d.; strictly net.

Contents.

Part I. **Plain Undecorated Pottery.—Clays:** Classification; General Properties and Composition; Working of Clay-Pits—Open Pits—Underground Pits. Preparation of the Clay. **Bricks:** Hand and Machine Moulding—Expression Machines—Dies—Cutting-tables—General Remarks on the Choice of Machines—Types of Installations—Estimates—Plenishing, Hand and Steam Presses—Drying, by Exposure to Air, Without Shelter, and Under Sheds—Drying-rooms in Tiers, Closed Drying-rooms, in Tunnels, in Galleries—Detailed Estimates of the Various Drying-rooms, Comparison of Prices—Transport from the Machines to the Drying-rooms—Firing—In Clamps—In Intermittent Kilns—Continuous Kilns: with Solid Fuel: Round Kiln, Rectangular Kiln, Chimneys (Plans and Estimates)—With Gas Fuel, Fillard Kiln (Plans and Estimates), Water-gas Kiln—Heat Production of the Kilns; Dimensions, Shapes, Colours, Decoration, and Quality of Bricks—Hollow Bricks, Dimensions and Prices of Bricks, Various Shapes, Qualities—Use of Bricks—Walls, Arches, Pavements, Flues, Cornices—Facing with Coloured Bricks—Balustrades. **Tiles:** Manufacture—Moulding, by Hand, by Machinery: Preparation of the Clay—Preparation of the Slabs, Transformation into Flat Tiles, into Jointed Tiles—Screw, Cam and Revolver Presses—Particulars of Tile-presses—Drying—Planchettes, Shelves, Drying-barrows and Trucks—Firing—Divided Kilns—Installation of Mechanical Tileworks—Estimates; Shapes, Dimensions and Uses of the Principal Types of Tile—Ancient Tiles—Foreign Tiles—Special Tiles—Ridge Tiles, Coping Tiles, Border Tiles, Frontons, Gutters, Antefixes, Membron, Angular—Roofing Accessories: Chimney-pots, Mitrons, Lanterns, Chimneys—Qualities of Tiles—Black Tiles—Stoneware Tiles—Particulars of Tiles. **Pipes:** Conduit Pipes—Manufacture—Moulding: Horizontal Machines, Vertical Machines—Drying—Firing—**Chimney Flues**—Ventiducts and "Boisseaux," "Waggons"—Particulars of these Products. **Quarries:** Plain Quarries of Ordinary Clay; of Cleaned Clay—Machines, Cutting, Mixing, Polishing—Drying and Firing—Applications—Particulars of Quarries. **Terra-cotta:** History—Manufacture—Application: Balustrades, Columns, Pilasters, Capitals, Friezes, Frontons, Medallions, Panels, Rose-windows, Ceilings—Appendix: Official Methods of Testing Terra-cottas.

Part II. **Made-up or Decorated Pottery.**—General Remarks on the Decoration of Pottery: Dips—Glazes: Composition, Colouring, Preparation, Harmony with Pastes—Special Processes of Decoration—Enamels, Opaque, Transparent, Colours, Underglaze, Over-glaze—Other Processes: Crackling, Mottled, Flashing, Metallic Iridescence, Lustres. Glazed and Enamelled Bricks—History: Glazing—Enamelling—Applications: Ordinary Enamelled Bricks, Glazed Stoneware, Enamelled Stoneware—Enamelled Tiles. Decorated Quarries: Paving Quarries—Decorated with Dips—Stoneware: Applications—Plain or Incrusted Stoneware; Manufacture—Application—Colouring, Manufacture, Moulding, Drying, Firing—Applications—Facing Quarries—in Faïence—of Glazed Stoneware—of Porcelain—Applications of Facing Quarries—Stove Quarries—Preparation of the Pastes, Moulding, Firing, Enamelling, Decoration—Applications—Faïences for Fireplaces. Architectural Decorated Pottery: Faïences; Stoneware; Porcelain. Sanitary Pottery: Stoneware Pipes: Manufacture, Firing—Applications—Sinks—Applications—Urinals, Seats and Pans—Applications—Drinking-fountains, Washstands—Index.

THE ART OF RIVETING GLASS, CHINA AND EARTHENWARE. By J. HOWARTH. Second Edition. 1900. Paper Cover. Price 1s. net; by post, home or abroad, 1s. 1d.

HOW TO ANALYSE CLAY. Practical Methods for Practical Men. By HOLDEN M. ASHBY, Professor of Organic Chemistry, Harvey Medical College, U.S.A. Twenty Illustrations. 1898. Price 2s. 6d.; Abroad, 3s.; strictly net.

NOTES ON POTTERY CLAYS. Their Distribution, Properties, Uses and Analyses of Ball Clays, China Clays and China Stone. By JAS. FAIRIE, F.G.S. 1901. 132 pp. Crown 8vo. Price 3s. 6d.; India and Colonies, 4s.; Other Countries, 4s. 6d.; strictly net.

A Reissue of

THE HISTORY OF THE STAFFORDSHIRE POTTERIES; AND THE RISE AND PROGRESS OF THE MANUFACTURE OF POTTERY AND PORCELAIN. With References to Genuine Specimens, and Notices of Eminent Potters. By SIMEON SHAW. (Originally Published in 1829.) 265 pp. 1900. Demy 8vo. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Introductory Chapter showing the position of the Pottery Trade at the present time 1899)—**Preliminary Remarks—The Potteries**, comprising Tunstall, Brownhills, Greenfield and New Field, Golden Hill, Latebrook, Green Lane, Burslem, Longport and Dale Hall, Hot Lane and Cobridge, Hanley and Shelton, Etruria, Stoke, Penkhull, Fenton, Lane Delph, Foley, Lane End—**On the Origin of the Art**, and its Practice among the early Nations—**Manufacture of Pottery**, prior to 1700—**The Introduction of Red Porcelain** by Messrs. Elers, of Bradwell, 1690—**Progress of the Manufacture** from 1700 to Mr. Wedgwood's commencement in 1760—**Introduction of Fluid Glaze**—Extension of the Manufacture of Cream Colour—Mr. Wedgwood's Queen's Ware—Jasper, and Appointment of Potter to Her Majesty—Black Printing—**Introduction of Porcelain.** Mr. W. Littler's Porcelain—Mr. Cookworthy's Discovery of Kaolin and Petuntse, and Patent—Sold to Mr. Champion—resold to the New Hall Com.—Extension of Term—**Blue Printed Pottery.** Mr. Turner, Mr. Spode (1), Mr. Baddeley, Mr. Spode (2), Messrs. Turner, Mr. Wood, Mr. Wilson, Mr. Minton—Great Change in Patterns of Blue Printed—**Introduction of Lustre Pottery.** Improvements in Pottery and Porcelain subsequent to 1800.

A Reissue of

THE CHEMISTRY OF THE SEVERAL NATURAL AND ARTIFICIAL HETEROGENEOUS COMPOUNDS USED IN MANUFACTURING PORCELAIN, GLASS AND POTTERY. By SIMEON SHAW. (Originally published in 1837.) 750 pp. 1900. Royal 8vo. Price 14s.; India and Colonies, 15s.; Other Countries, 16s. 6d.; strictly net.

Contents.

PART I., ANALYSIS AND MATERIALS.—**Introduction**: Laboratory and Apparatus; **Elements—Temperature—Acids and Alkalies—The Earths—Metals.**

PART II., SYNTHESIS AND COMPOUNDS.—**Science of Mixing—Bodies**: Porcelain—Hard, Porcelain—Fritted Bodies, Porcelain—Raw Bodies, Porcelain—Soft, Fritted Bodies, Raw Bodies, Stone Bodies, Ironstone, Dry Bodies, Chemical Utensils, Fritted Jasper, Fritted Pearl, Fritted Drab, Raw Chemical Utensils, Raw Stone, Raw Jasper, Raw Pearl, Raw Mortar, Raw Drab, Raw Brown, Raw Fawn, Raw Cane, Raw Red Porous, Raw Egyptian, Earthenware, Queen's Ware, Cream Colour, Blue and Fancy Printed, Dipped and Mocha, Chalky, Rings, Stilts, etc.—**Glazes**: Porcelain—Hard Fritted Porcelain—Soft Fritted Porcelain—Soft Raw, Cream Colour Porcelain, Blue Printed Porcelain, Fritted Glazes, Analysis of Fritt, Analysis of Glaze, Coloured Glazes, Dips, Smears and Washes; **Glasses**: Flint Glass, Coloured Glasses, Artificial Garnet, Artificial Emerald, Artificial Amethyst, Artificial Sapphire, Artificial Opal, Plate Glass, Crown Glass, Broad Glass, Bottle Glass, Phosphoric Glass, British Steel Glass, Glass-Staining and Painting, Engraving on Glass, Dr. Faraday's Experiments—**Colours**: Colour Making, Fluxes or Solvents, Components of the Colours; **Reds, etc., from Gold**, Carmine or Rose Colour, Purple, Reds, etc., from Iron, Blues, Yellows, Greens, Blacks, White, Silver for Burnishing, Gold for Burnishing, Printer's Oil, Lustres.

TABLES OF THE CHARACTERISTICS OF CHEMICAL SUBSTANCES.

Glassware, Glass Staining and Painting.

RECIPES FOR FLINT GLASS MAKING. By a British Glass Master and Mixer. Sixty Recipes. Being Leaves from the Mixing Book of several experts in the Flint Glass Trade, containing up-to-date recipes and valuable information as to Crystal, Demi-crystal and Coloured Glass in its many varieties. It contains the recipes for cheap metal suited to pressing, blowing, etc., as well as the most costly crystal and ruby. Price for United Kingdom, 10s. 6d.; Abroad, 15s.; United States, $4; strictly net.

Contents.

Ruby—Ruby from Copper—Flint for using with the Ruby for Coating—A German Metal—Cornelian, or Alabaster—Sapphire Blue—Crysophis—Opal—Turquoise Blue—Gold Colour—Dark Green—Green (common)—Green for Malachite—Blue for Malachite—Black for Melachite—Black—Common Canary Batch—Canary—White Opaque Glass—Sealing-wax Red—Flint—Flint Glass (Crystal and Demi)—Achromatic Glass—Paste Glass—White Enamel—Firestone—Dead White (for moons)—White Agate—Canary—Canary Enamel—Index.

A TREATISE ON THE ART OF GLASS PAINTING. Prefaced with a Review of Ancient Glass. By ERNEST R. SUFFLING. With One Coloured Plate and Thirty-seven Illustrations. Demy 8vo. 140 pp. 1902. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d. net.

Contents.

A Short History of Stained Glass—Designing Scale Drawings—Cartoons and the Cut Line—Various Kinds of Glass Cutting for Windows—The Colours and Brushes used in Glass Painting—Painting on Glass, Dispersed Patterns—Diapered Patterns—Aciding—Firing—Fret Lead Glazing—Index.

PAINTING ON GLASS AND PORCELAIN AND ENAMEL PAINTING. A Complete Introduction to the Preparation of all the Colours and Fluxes used for Painting on Porcelain, Enamel, Faience and Stoneware, the Coloured Pastes and Coloured Glasses, together with a Minute Description of the Firing of Colours and Enamels. By FELIX HERMANN, Technical Chemist. With Eighteen Illustrations. 300 pp. Translated from the German second and enlarged Edition. 1897. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

History of Glass Painting—The Articles to be Painted: Glass, Porcelain, Enamel, Stoneware, Faience—Pigments: Metallic Pigments: Antimony Oxide, Naples Yellow, Barium Chromate, Lead Chromate, Silver Chloride, Chromic Oxide—Fluxes: Fluxes, Felspar, Quartz, Purifying Quartz, Sedimentation, Quenching, Borax, Boracic Acid, Potassium and Sodium Carbonates, Rocaille Flux—Preparation of the Colours for Glass Painting—The Colour Pastes—The Coloured Glasses—Composition of the Porcelain Colours—The Enamel Colours: Enamels for Artistic Work—Metallic Ornamentation: Porcelain Gilding, Glass Gilding—Firing the Colours: Remarks on Firing: Firing Colours on Glass, Firing Colours on Porcelain; The Muffle—Accidents occasionally Supervening during the Process of Firing—Remarks on the Different Methods of Painting on Glass, Porcelain, etc.—Appendix: Cleaning Old Glass Paintings.

Paper Staining.

THE DYEING OF PAPER PULP. A Practical Treatise for the use of Papermakers, Paperstainers, Students and others. By JULIUS ERFURT, Manager of a Paper Mill. Translated into English and Edited with Additions by JULIUS HÜBNER, F.C.S., Lecturer on Papermaking at the Manchester Municipal Technical School. With Illustrations and **157 patterns of paper dyed in the pulp.** Royal 8vo, 180 pp. 1901. Price 15s.; India and Colonies, 16s.; Other Countries, 20s.; strictly net. Limited edition.

Contents.

Behaviour of the Paper Fibres during the Process of Dyeing, Theory of the Mordant—Colour Fixing Mediums (Mordants)—Influence of the Quality of the Water Used—Inorganic Colours—Organic Colours—Practical Application of the Coal Tar Colours according to their Properties and their Behaviour towards the Different Paper Fibres—Dyed Patterns on Various Pulp Mixtures—Dyeing to Shade—Index.

Enamelling on Metal.

ENAMELS AND ENAMELLING. For Enamel Makers, Workers in Gold and Silver, and Manufacturers of Objects of Art. By PAUL RANDAU. Translated from the German. With Sixteen Illustrations. 180 pp. 1900. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Composition and Properties of Glass—Raw Materials for the Manufacture of Enamels—Substances Added to Produce Opacity—Fluxes—Pigments—Decolorising Agents—Testing the Raw Materials with the Blow-pipe Flame—Subsidiary Materials—Preparing the Materials for Enamel Making—Mixing the Materials—The Preparation of Technical Enamels, The Enamel Mass—Appliances for Smelting the Enamel Mass—Smelting the Charge—Composition of Enamel Masses—Composition of Masses for Ground Enamels—Composition of Cover Enamels—Preparing the Articles for Enamelling—Applying the Enamel—Firing the Ground Enamel—Applying and Firing the Cover Enamel or Glaze—Repairing Defects in Enamelled Ware—Enamelling Articles of Sheet Metal—Decorating Enamelled Ware—Specialities in Enamelling—Dial-plate Enamelling—Enamels for Artistic Purposes, Recipes for Enamels of Various Colours—Index.

THE ART OF ENAMELLING ON METAL. By W. NORMAN BROWN. Twenty-eight Illustrations. Crown 8vo. 60 pp. 1900. Price 2s. 6d.; Abroad, 3s.; strictly net.

Silk Manufacture.

SILK THROWING AND WASTE SILK SPINNING. By HOLLINS RAYNER. Demy 8vo. 130 Illustrations.

[*In the Press.*

Contents.

The Silkworm—Cocoon Reeling and Qualities of Silk—Silk Throwing—Silk Wastes—The Preparation of Silk Waste for Degumming—Silk Waste Degumming, Schapping and Discharging—The Opening and Dressing of Wastes—Silk Waste "Drawing" or "Preparing" Machinery—Long Spinning—Short Spinning—Spinning and Finishing Processes—Utilisation of Waste Products—Noil Spinning—Exhaust Noil Spinning.

Books on Textile and Dyeing Subjects.

THE CHEMICAL TECHNOLOGY OF TEXTILE FIBRES: Their Origin, Structure, Preparation, Washing, Bleaching, Dyeing, Printing and Dressing. By Dr. GEORG VON GEORGIEVICS. Translated from the German by CHARLES SALTER. 320 pp. Forty-seven Illustrations. Royal 8vo. 1902. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s. net.

Contents.

The Textile Fibres—Artificial Fibres—Mineral Fibres—Vegetable Fibres—Cellulose—Cotton—Bombax Cotton—Vegetable Silk—Flax—Hemp—Jute—Ramie, Rhea, China Grass, Nettle Fibre—Distinguishing Tests for the Various Fibres—Animal Fibres: Silk—Animal Hairs—Sheep's Wool—Goat Wool and Camel Wool—Artificial Wool (Wool Substitutes)—Conditioning—**Washing, Bleaching, Carbonising**—Bleaching Agents—Cotton Bleaching—Linen Bleaching—Jute Bleaching—Hemp Bleaching—Ramie Bleaching—Scouring and Bleaching Silk—Washing and Bleaching Wool—Blueing or White Dyeing—Carbonising—**Mordants and Mordanting—Dyeing**—Combination of Colours: Dyeing to Pattern—Theory of Dyeing—Classification of Dye Stuffs: Methods of Dyeing—Application of Acid Dye Stuffs—Application of Basic Dye Stuffs—Application of Direct or Substantive Cotton Dyes—Application of the Mordant Dyes—Application of the Developing Dyes—Dyeing on a Manufacturing Scale: Selection of Dye Stuffs for Dyeing—Silk Dyeing—Wool Dyeing—Cotton Dyeing—Dyeing Mixed Fabrics—Sample Dyeings, Colorimetric Determinations, Reactions of Dye Stuffs on the Fibre, Tests for Fastness—**Printing**—Hand Printing—Calico Printing: Reproduction of Pattern by Direct Printing: Thickening Agents—Employment of Mordant Dye Stuffs, Basic, Albumin, Direct, Developing, Vat, Acid—Treatment of the Goods when Printed—Combined Printing and Dyeing—Discharge Style Printing—Reserve Style Printing—Topping Printing—Wool Printing—Silk Printing—Printing Yarns, Warps, and Combed Sliver—**Dressing and Finishing**—Dressing and Finishing—Substances used in Finishing—Loading Ingredients—Colouring for the Dressing Preparations—Metals or their Sulphites—Waterproofing—Fireproofing—Antiseptics for Prevention of Mould—Application of Dressings—Drying—Stretching—Finishing: Shearing, Damping, Calendering, Beetling, Moiré or Watered Effects, Stamping—Finishing Woollens—Index.

POWER-LOOM WEAVING AND YARN NUMBERING,

According to Various Systems, with Conversion Tables. Translated from the German of ANTHON GRUNER. **With Twenty-six Diagrams in Colours.** 150 pp. 1900. Crown 8vo. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Power-Loom Weaving in General. Various Systems of Looms—**Mounting and Starting the Power-Loom.** English Looms—Tappet or Treadle Looms—Dobbies—**General Remarks on the Numbering, Reeling and Packing of Yarn—Appendix—Useful Hints.** Calculating Warps—Weft Calculations—Calculations of Cost Price in Hanks.

TEXTILE RAW MATERIALS AND THEIR CONVERSION INTO YARNS. (The Study of the Raw Materials and the Technology of the Spinning Process.)

By JULIUS ZIPSER. Translated from German by CHARLES SALTER. 302 Illustrations. 500 pp. Demy 8vo. 1901. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

PART I.—The Raw Materials Used in the Textile Industry.

MINERAL RAW MATERIALS. VEGETABLE RAW MATERIALS. ANIMAL RAW MATERIALS.

PART II.—The Technology of Spinning or the Conversion of Textile Raw Materials into Yarn.

SPINNING VEGETABLE RAW MATERIALS. Cotton Spinning—Installation of a Cotton Mill—Spinning Waste Cotton and Waste Cotton Yarns—Flax Spinning—Fine Spinning—Tow Spinning—Hemp Spinning—Spinning Hemp Tow String—Jute Spinning—Spinning Jute Line Yarn—Utilising Jute Waste.

PART III.—Spinning Animal Raw Materials.

Spinning Carded Woollen Yarn—Finishing Yarn—Worsted Spinning—Finishing Worsted Yarn—Artificial Wool or Shoddy Spinning—Shoddy and Mungo Manufacture—Spinning Shoddy and other Wool Substitutes—Spinning Waste Silk—Chappe Silk—Fine Spinning—Index.

THE TECHNICAL TESTING OF YARNS AND TEXTILE FABRICS.

With Reference to Official Specifications. Translated from the German of Dr. J. HERZFELD. Second Edition. Sixty-nine Illustrations. 200 pp. Demy 8vo. 1902. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Yarn Testing. Determining the Yarn Number—Testing the Length of Yarns—Examination of the External Appearance of Yarn—Determining the Twist of Yarn and Twist—Determination of Tensile Strength and Elasticity—Estimating the Percentage of Fat in Yarn—Determination of Moisture (Conditioning)—**Appendix.**

DECORATIVE AND FANCY TEXTILE FABRICS.

By R. T. LORD. Manufacturers and Designers of Carpets, Damask, Dress and all Textile Fabrics. 200 pp. 1898. Demy 8vo. 132 Designs and Illustrations. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

A Few Hints on Designing Ornamental Textile Fabrics—A Few Hints on Designing Ornamental Textile Fabrics (continued)—A Few Hints on Designing Ornamental Textile Fabrics (continued)—A Few Hints on Designing Ornamental Textile Fabrics (continued)—Hints for Ruled-paper Draughtsmen—The Jacquard Machine—Brussels and Wilton Carpets—Tapestry Carpets—Ingrain Carpets—Axminster Carpets—Damask and Tapestry Fabrics—Scarf Silks and Ribbons—Silk Handkerchiefs—Dress Fabrics—Mantle Cloths—Figured Plush—Bed Quilts—Calico Printing.

THEORY AND PRACTICE OF DAMASK WEAVING.

By H. KINZER and K. WALTER. Royal 8vo. Eighteen Plates. Six Illustrations. Translated from the German. [*In the press.*

Contents.

The Various Sorts of Damask Fabrics—Drill (Ticking, Handloom-made)—Whole Damask for Tablecloths—Damask with Ground- and Connecting-warp Threads—Furniture Damask—Lampas or Hangings—Church Damasks—**The Manufacture of Whole Damask**—Damask Arrangement with and without Cross-Shedding—The Altered Cone-arrangement—The Principle of the Corner Lifting Cord—The Roller Principle—The Combination of the Jacquard with the so-called Damask Machine—The Special Damask Machine—The Combination of Two Tyings.

FAULTS IN THE MANUFACTURE OF WOOLLEN GOODS AND THEIR PREVENTION. By NICOLAS REISER. Translated from the Second German Edition. Crown 8vo. Sixty-three Illustrations. [*In the press.*

Contents.

Improperly Chosen Raw Material or Improper Mixtures—Wrong Treatment of the Material in Washing, Carbonisation, Drying, Dyeing and Spinning—Improper Spacing of the Goods in the Loom—Wrong Placing of Colours—Wrong Weight or Width of the Goods—Breaking of Warp and Weft Threads—Presence of Doubles, Singles, Thick, Loose, and too Hard Twisted Threads as well as Tangles, Thick Knots and the Like—Errors in Cross-weaving—Inequalities, *i.e.*, Bands and Stripes—Dirty Borders—Defective Selvedges—Holes and Buttons—Rubbed Places—Creases—Spots—Loose and Bad Colours—Badly Dyed Selvedges—Hard Goods—Brittle Goods—Uneven Goods—Removal of Bands, Stripes, Creases and Spots.

Dyeing, Colour Printing, Matching and Dye-stuffs.

THE COLOUR PRINTING OF CARPET YARNS. Manual for Colour Chemists and Textile Printers. By DAVID PATERSON, F.C.S. Seventeen Illustrations. 136 pp. Demy 8vo. 1900. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Structure and Constitution of Wool Fibre—Yarn Scouring—Scouring Materials—Water for Scouring—Bleaching Carpet Yarns—Colour Making for Yarn Printing—Colour Printing Pastes—Colour Recipes for Yarn Printing—Science of Colour Mixing—Matching of Colours—"Hank" Printing—Printing Tapestry Carpet Yarns—Yarn Printing—Steaming Printed Yarns—Washing of Steamed Yarns—Aniline Colours Suitable for Yarn Printing—Glossary of Dyes and Dye-wares used in Wood Yarn Printing—Appendix.

THE SCIENCE OF COLOUR MIXING. A Manual intended for the use of Dyers, Calico Printers and Colour Chemists. By DAVID PATERSON, F.C.S. Forty-one Illustrations, **Five Coloured Plates, and Four Plates showing Eleven Dyed Specimens of Fabrics.** 132 pp. Demy 8vo. 1900. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Colour a Sensation; Colours of Illuminated Bodies; Colours of Opaque and Transparent Bodies; Surface Colour—Analysis of Light; Spectrum; Homogeneous Colours; Ready Method of Obtaining a Spectrum—Examination of Solar Spectrum; The Spectroscope and Its Construction; Colourists' Use of the Spectroscope—Colour by Absorption; Solutions and Dyed Fabrics; Dichroic Coloured Fabrics in Gaslight—Colour Primaries of the Scientist *versus* the Dyer and Artist; Colour Mixing by Rotation and Lye Dyeing; Hue, Purity, Brightness; Tints; Shades, Scales, Tones, Sad and Sombre Colours—Colour Mixing; Pure and Impure Greens, Orange and Violets; Large Variety of Shades from few Colours; Consideration of the Practical Primaries: Red, Yellow and Blue—Secondary Colours; Nomenclature of Violet and Purple Group; Tints and Shades of Violet; Changes in Artificial Light—Tertiary Shades; Broken Hues; Absorption Spectra of Tertiary Shades—Appendix: Four Plates with Dyed Specimens Illustrating Text—Index.

COLOUR MATCHING ON TEXTILES. A Manual intended for the use of Students of Colour Chemistry, Dyeing and Textile Printing. By DAVID PATERSON, F.C.S. Coloured Frontispiece. Twenty-nine Illustrations and Fourteen Specimens of Dyed Fabrics. Demy 8vo. 132 pp. 1901. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Colour Vision and Structure of the Eye—Perception of Colour—Primary and Complementary Colour Sensations—Daylight for Colour Matching—Selection of a Good Pure Light—Diffused Daylight, Direct Sunlight, Blue Skylight, Variability of Daylight, etc., etc.—Matching of Hues—Purity and Luminosity of Colours—Matching Bright Hues—Aid of Tinted Films—Matching Difficulties Arising from Contrast—Examination of Colours by Reflected

and Transmitted Lights—Effect of Lustre and Transparency of Fibres in Colour Matching—Matching of Colours on Velvet Pile—Optical Properties of Dye-stuffs. Dichroism, Fluorescence—Use of Tinted Mediums—Orange Film—Defects of the Eye—Yellowing of the Lens—Colour Blindness, etc.—Matching of Dyed Silk Trimmings and Linings and Bindings—Its Difficulties—Behaviour of Shades in Artificial Light—Colour Matching of Old Fabrics, etc.—Examination of Dyed Colours under the Artificial Lights—Electric Arc, Magnesium and Dufton, Gardner Lights, Welsbach, Acetylene, etc.—Testing Qualities of an Illuminant—Influence of the Absorption Spectrum in Changes of Hue under the Artificial Lights—Study of the Causes of Abnormal Modifications of Hue, etc.

COLOUR: A HANDBOOK OF THE THEORY OF COLOUR. By GEORGE H. HURST, F.C.S. **With Ten Coloured Plates** and Seventy-two Illustrations. 160 pp. Demy 8vo. 1900. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Colour and Its Production. Light, Colour, Dispersion of White Light, Methods of Producing the Spectrum, Glass Prism and Diffraction Grating Spectroscopes, The Spectrum, Wave Motion of Light, Recomposition of White Light, Hue, Luminosity, Purity of Colours, The Polariscope, Phosphorescence, Fluorescence, Interference—**Cause of Colour in Coloured Bodies.** Transmitted Colours, Absorption Spectra of Colouring Matters—**Colour Phenomena and Theories.** Mixing Colours, White Light from Coloured Lights, Effect of Coloured Light on Colours, Complementary Colours, Young Helmholtz Theory, Brewster Theory, Supplementary Colours, Maxwell's Theory, Colour Photography—**The Physiology of Light.** Structure of the Eye, Persistence of Vision, Subjective Colour Phenomena, Colour Blindness—**Contrast.** Contrast, Simultaneous Contrast, Successive Contrast, Contrast of Tone, Contrast of Colours, Modification of Colours by Contrast, Colour Contrast in Decorative Design—**Colour in Decoration and Design.** Colour Harmonies, Colour Equivalents, Illumination and Colour, Colour and Textile Fabrics, Surface Structure and Colour—**Measurement of Colour.** Colour Patch Method, The Tintometer, Chromometer.

THE DYEING OF COTTON FABRICS: A Practical Handbook for the Dyer and Student. By FRANKLIN BEECH, Practical Colourist and Chemist. 272 pp. Forty-four Illustrations of Bleaching and Dyeing Machinery. Demy 8vo. 1901. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Structure and Chemistry of the Cotton Fibre—Scouring and Bleaching of Cotton—Dyeing Machinery and Dyeing Manipulations—Principles and Practice of Cotton Dyeing—Direct Dyeing; Direct Dyeing followed by Fixation with Metallic Salts; Direct Dyeing followed by Fixation with Developers; Direct Dyeing followed by Fixation with Couplers; Dyeing on Tannic Mordant; Dyeing on Metallic Mordant; Production of Colour Direct upon Cotton Fibres; Dyeing Cotton by Impregnation with Dye-stuff Solution—Dyeing Union (Mixed Cotton and Wool) Fabrics—Dyeing Half Silk (Cotton-Silk, Satin) Fabrics—Operations following Dyeing—Washing, Soaping, Drying—Testing of the Colour of Dyed Fabrics—Experimental Dyeing and Comparative Dye Testing—Index.

The book contains numerous recipes for the production on Cotton Fabrics of all kinds of a great range of colours.

THE DYEING OF WOOLLEN FABRICS. By FRANKLIN BEECH, Practical Colourist and Chemist. Thirty-three Illustrations. Demy 8vo. 228 pp. 1902. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d. net.

Contents.

The Wool Fibre—Structure, Composition and Properties—Processes Preparatory to Dyeing—Scouring and Bleaching of Wool—Dyeing Machinery and Dyeing Manipulations—Loose Wool Dyeing, Yarn-Dyeing and Piece Dyeing Machinery—The Principles and Practice of Wool Dyeing—Properties of Wool Dyeing—Methods of Wool Dyeing—Groups of Dyes—Dyeing with the Direct Dyes—Dyeing with Basic Dyes—Dyeing with Acid Dyes—Dyeing with Mordant Dyes—Level Dyeing—Blacks on Wool—Reds on Wool—Mordanting of Wool—Orange Shades on Wool—Yellow Shades on Wool—Green Shades on Wool—Blue Shades on Wool—Violet Shades on Wool—Brown Shades on Wool—Mode Colours on Wool—Dyeing Union (Mixed Cotton Wool) Fabrics—Dyeing of Gloria—Operations following Dyeing—Washing, Soaping, Drying—Experimental Dyeing and Comparative Dye Testing—Testing of the Colour of Dyed Fabrics—Index.

DYERS' MATERIALS: An Introduction to the Examination, Evaluation and Application of the most important Substances used in Dyeing, Printing, Bleaching and Finishing. By PAUL HEERMAN, Ph.D. Translated from the German by. A C. WRIGHT, M.A. (Oxon.), B.Sc. (Lond.). Twenty-four Illustrations. Crown 8vo. 150 pp. 1901. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Indicators—Standard Solutions—Solutions and Reagents in General Use—Water—Textile Fibres—Hydrochloric Acid—Chlorides—Fluorides and Bifluorides—Sulphuric Acid—Sulphates—Nitric Acid and Nitrates—Chlorine-Oxygen Compounds—Sulphite Compounds—Miscellaneous Compounds—Alkalies—Peroxides—Zinc Dust—Fatty Acids and Their Salts—Cyanogen Compounds—Derivatives of the Fats—Tannins—Aniline and Aniline Salts—Thickening and Stiffening Materials: Starch, Prepared and Soluble Starch, Dextrine, Gum Arabic, Gum Senegal, Gum Tragacanth, Glue, Size—*Dyes*—Appendix: Atomic Weights of the Elements—Molecular Weights of Certain Compounds—Gravimetric Equivalents—Volumetric Equivalents—Plate I., Microscopic Appearance of the Textile Fibres—Plate II., Microscopic Appearance of the Different Varieties of Starch—Index.

Reissue of

THE ART OF DYEING WOOL, SILK AND COTTON. Translated from the French of M. HELLOT, M. MACQUER and M. LE PILEUR D'APLIGNY. First Published in English in 1789. Six Plates. Demy 8vo. 446 pp. 1901. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Part I., **The Art of Dyeing Wool and Woollen Cloth, Stuffs, Yarn, Worsted, etc.** Part II., **The Art of Dyeing Silk.** Part III., **The Art of Dyeing Cotton and Linen Thread, together with the Method of Stamping Silks, Cottons, etc.**

THE CHEMISTRY OF DYE-STUFFS. By Dr. GEORG VON GEORGIEVICS. Translated from the Second German Edition. 412 pp. Demy 8vo. 1903. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Introduction—Coal Tar—Intermediate Products in the Manufacture of Dye-stuffs—The Artificial Dye-stuffs (Coal-tar Dyes)—Nitroso Dye-stuffs—Nitro Dye-stuffs—Azo Dye-stuffs—Substantive Cotton Dye-stuffs—Azoxystilbene Dye-stuffs—Hydrazones—Ketoneimides—Triphenylmethane Dye-stuffs—Rosolic Acid Dye-stuffs—Xanthene Dye-stuffs—Xanthone Dye-stuffs—Flavones—Oxyketone Dye-stuffs—Quinoline and Acridine Dye-stuffs—Quinonimide or Diphenylamine Dye-stuffs—The Azine Group: Eurhodines, Safranines and Indulines—Eurhodines—Safranines—Quinoxalines—Indigo—Dye-stuffs of Unknown Constitution—Sulphur or Sulphine Dye-stuffs—Development of the Artificial Dye-stuff Industry—The Natural Dye-stuffs—Mineral Colours—Index.

Bleaching and Washing.

A PRACTICAL TREATISE ON THE BLEACHING OF LINEN AND COTTON YARN AND FABRICS. By L. TAILFER, Chemical and Mechanical Engineer. Translated from the French by JOHN GEDDES MCINTOSH. Demy 8vo. 303 pp. Twenty Illusts. 1901. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

General Considerations on Bleaching—Steeping—Washing: Its End and Importance—Roller Washing Machines—Wash Wheel (Dash Wheel)—Stocks or Wash Mill—Squeezing—Lye Boiling—Lye Boiling with Milk of Lime—Lye Boiling with Soda Lyes—Description of Lye Boiling Keirs—Operations of Lye Boiling—Concentration of Lyes—Mather and Platt's Keir—Description of the Keir—Saturation of the Fabrics—Alkali used in Lye Boiling—Examples of Processes—Soap—Action of Soap in Bleaching—Quality and Quantity of Soaps to use in the Lye—Soap Lyes or Scalds—Soap Scouring Stocks—Bleaching on Grass or on the Bleaching Green or Lawn—Chemicking—Remarks on Chlorides and their Decolour-

ising Action—Chemicking Cisterns—Chemicking—Strengths, etc.—Sours—Properties of the Acids—Effects Produced by Acids—Souring Cisterns—Drying—Drying by Steam—Drying by Hot Air—Drying by Air—Damages to Fabrics in Bleaching—Yarn Mildew—Fermentation—Iron Rust Spots—Spots from Contact with Wood—Spots incurred on the Bleaching Green—Damages arising from the Machines—Examples of Methods used in Bleaching—Linen—Cotton—The Valuation of Caustic and Carbonated Alkali (Soda) and General Information Regarding these Bodies—Object of Alkalimetry—Titration of Carbonate of Soda—Comparative Table of Different Degrees of Alkalimetrical Strength—Five Problems relative to Carbonate of Soda—Caustic Soda, its Properties and Uses—Mixtures of Carbonated and Caustic Alkali—Note on a Process of Manufacturing Caustic Soda and Mixtures of Caustic and Carbonated Alkali (Soda)—Chlorometry—Titration—Wagner's Chlorometric Method—Preparation of Standard Solutions—Apparatus for Chlorine Valuation—Alkali in Excess in Decolourising Chlorides—Chlorine and Decolourising Chlorides—Synopsis—Chlorine—Chloride of Lime—Hypochlorite of Soda—Brochoki's Chlorozone—Various Decolourising Hypochlorites—Comparison of Chloride of Lime and Hypochlorite of Soda—Water—Qualities of Water—Hardness—Dervaux's Purifier—Testing the Purified Water—Different Plant for Purification—Filters—Bleaching of Yarn—Weight of Yarn—Lye Boiling—Chemicking—Washing—Bleaching of Cotton Yarn—The Installation of a Bleach Works—Water Supply—Steam Boilers—Steam Distribution Pipes—Engines—Keirs—Washing—Machines—Stocks—Wash Wheels—Chemicking and Souring Cisterns—Various—Buildings—Addenda—Energy of Decolourising Chlorides and Bleaching by Electricity and Ozone—Energy of Decolourising Chlorides—Chlorides—Production of Chlorine and Hypochlorites by Electrolysis—Lunge's Process for increasing the intensity of the Bleaching Power of Chloride of Lime—Trilfer's Process for Removing the Excess of Lime or Soda from Decolourising Chlorides—Bleaching by Ozone.

Cotton Spinning and Combing.

COTTON SPINNING (First Year). By THOMAS THORNLEY, Spinning Master, Bolton Technical School. 160 pp. Eighty-four Illustrations. Crown 8vo. 1901. Price 3s.; Abroad, 3s. 6d.; strictly net.

Contents.

Syllabus and Examination Papers of the City and Guilds of London Institute—Cultivation, Classification, Ginning, Baling and Mixing of the Raw Cotton—Bale-Breakers, Mixing Lattices and Hopper Feeders—Opening and Scutching—Carding—Indexes.

COTTON SPINNING (Intermediate, or Second Year). By THOMAS THORNLEY. 180 pp. Seventy Illustrations. Crown 8vo. 1901. Price 5s.; India and British Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Syllabuses and Examination Papers of the City and Guilds of London Institute—The Combing Process—The Drawing Frame—Bobbin and Fly Frames—Mule Spinning—Ring Spinning—General Indexes.

COTTON SPINNING (Honours, or Third Year). By THOMAS THORNLEY. 216 pp. Seventy-four Illustrations. Crown 8vo. 1901. Price 5s.; India and British Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Syllabuses and Examination Papers of the City and Guilds of London Institute—Cotton—The Practical Manipulation of Cotton Spinning Machinery—Doubling and Winding—Reeling—Warping—Production and Costs—Main Driving—Arrangement of Machinery and Mill Planning—Waste and Waste Spinning—Indexes.

COTTON COMBING MACHINES. By THOS. THORNLEY, Spinning Master, Technical School, Bolton. Demy 8vo. 117 Illustrations. 300 pp. 1902. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d. net.

Contents.

The Sliver Lap Machine and the Ribbon Cap Machine—General Description of the Heilmann Comber—The Cam Shaft—On the Detaching and Attaching Mechanism of the Comber—Resetting of Combers—The Erection of a Heilmann Comber—Stop Motions: Various Calculations—Various Notes and Discussions—Cotton Combing Machines of Continental Make—Index.

Collieries and Mines.

RECOVERY WORK AFTER PIT FIRES. A Description of the Principal Methods Pursued, especially in Fiery Mines, and of the Various Appliances Employed, such as Respiratory and Rescue Apparatus, Dams, etc. By ROBERT LAMPRECHT, Mining Engineer and Manager. Translated from the German. Illustrated by Six large Plates, containing Seventy-six Illustrations. 175 pp., demy 8vo. 1901. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

Causes of Pit Fires—Preventive Regulations: (1) The Outbreak and Rapid Extension of a Shaft Fire can be most reliably prevented by Employing little or no Combustible Material in the Construction of the Shaft; (2) Precautions for Rapidly Localising an Outbreak of Fire in the Shaft; (3) Precautions to be Adopted in case those under 1 and 2 Fail or Prove Inefficient. Precautions against Spontaneous Ignition of Coal. Precautions for Preventing Explosions of Fire-damp and Coal Dust. Employment of Electricity in Mining, particularly in Fiery Pits. Experiments on the Ignition of Fire-damp Mixtures and Clouds of Coal Dust by Electricity—**Indications of an Existing or Incipient Fire—Appliances for Working in Irrespirable Gases:** Respiratory Apparatus; Apparatus with Air Supply Pipes; Reservoir Apparatus; Oxygen Apparatus—**Extinguishing Pit Fires:** (*a*) Chemical Means; (*b*) Extinction with Water. Dragging down the Burning Masses and Packing with Clay; (*c*) Insulating the Seat of the Fire by Dams. Dam Building. Analyses of Fire Gases. Isolating the Seat of a Fire with Dams: Working in Irrespirable Gases ("Gas-diving"): Air-Lock Work. Complete Isolation of the Pit. Flooding a Burning Section isolated by means of Dams. Wooden Dams: Masonry Dams. Examples of Cylindrical and Dome-shaped Dams. Dam Doors: Flooding the Whole Pit—**Rescue Stations:** (*a*) Stations above Ground; (*b*) Underground Rescue Stations—**Spontaneous Ignition of Coal in Bulk**—Index.

VENTILATION IN MINES. By ROBERT WABNER, Mining Engineer. Translated from the German. Royal 8vo. Thirty Plates and Twenty-two Illustrations. 240 pp. 1903. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; strictly net.

Contents.

The Causes of the Contamination of Pit Air—The Means of Preventing the Dangers resulting from the Contamination of Pit Air—Calculating the Volume of Ventilating Current necessary to free Pit Air from Contamination—Determination of the Resistance Opposed to the Passage of Air through the Pit—Laws of Resistance and Formulæ therefor—Fluctuations in the Temperament or Specific Resistance of a Pit—Means for Providing a Ventilating Current in the Pit—Mechanical Ventilation—Ventilators and Fans—Determining the Theoretical, Initial, and True (Effective) Depression of the Centrifugal Fan—New Types of Centrifugal Fan of Small Diameter and High Working Speed—Utilising the Ventilating Current to the utmost Advantage and distributing the same through the Workings—Artificially retarding the Ventilating Current—Ventilating Preliminary Workings—Blind Headings—Separate Ventilation—Supervision of Ventilation—INDEX.

HAULAGE AND WINDING APPLIANCES USED IN MINING. By CARL VOLK. Translated from the German. Royal 8vo. With Six Plates and 146 Illustrations. [*In the press.*

Contents.

Haulage Appliances—Ropes—Haulage Tubs and Tracks—Cages and Winding Appliances—Winding Engines for Vertical Shafts—Winding without Ropes—Haulage in Levels and Inclines—The Working of Underground Engines—Machinery for Downhill Haulage.

Engineering, Smoke Prevention and Metallurgy.

THE PREVENTION OF SMOKE. Combined with the Economical Combustion of Fuel. By W. C. POPPLEWELL, M.Sc., A.M.Inst., C.E., Consulting Engineer. Forty-six Illustrations. 190 pp. 1901. Demy 8vo. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Fuel and Combustion— Hand Firing in Boiler Furnaces—Stoking by Mechanical Means—Powdered Fuel—Gaseous Fuel—Efficiency and Smoke Tests of Boilers—Some Standard Smoke Trials—The Legal Aspect of the Smoke Question—The Best Means to be adopted for the Prevention of Smoke—Index.

GAS AND COAL DUST FIRING. A Critical Review of the Various Appliances Patented in Germany for this purpose since 1885. By ALBERT PÜTSCH. 130 pp. Demy 8vo. 1901. Translated from the German. With 103 Illustrations. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Generators—Generators Employing Steam—Stirring and Feed Regulating Appliances—Direct Generators—Burners—Regenerators and Recuperators—Glass Smelting Furnaces—Metallurgical Furnaces—Pottery Furnace—Coal Dust Firing—Index.

THE HARDENING AND TEMPERING OF STEEL IN THEORY AND PRACTICE. By FRIDOLIN REISER. Translated from the German of the Third Edition. Crown 8vo. 120 pp. 1903. Price 5s.; India and British Colonies, 5s. 6d.; Other Countries, 6s.; strictly net.

Contents.

Steel—Chemical and Physical Properties of Steel, and their Casual Connection—Classification of Steel according to Use—Testing the Quality of Steel — Steel-Hardening—Investigation of the Causes of Failure in Hardening—Regeneration of Steel Spoilt in the Furnace—Welding Steel—Index.

SIDEROLOGY: THE SCIENCE OF IRON (The Constitution of Iron Alloys and Slags). Translated from German of HANNS FREIHERR V. JÜPTNER. 350 pp. Demy 8vo. Eleven Plates and Ten Illustrations. 1902. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; net.

Contents.

The Theory of Solution.—Solutions—Molten Alloys—Varieties of Solutions—Osmotic Pressure—Relation between Osmotic Pressure and other Properties of Solutions—Osmotic Pressure and Molecular Weight of the Dissolved Substance—Solutions of Gases—Solid Solutions—Solubility—Diffusion—Electrical Conductivity—Constitution of Electrolytes and Metals—Thermal Expansion. **Micrography.**—Microstructure—The Micrographic Constituents of Iron—Relation between Micrographical Composition, Carbon-Content, and Thermal Treatment of Iron Alloys—The Microstructure of Slags. **Chemical Composition of the Alloys of Iron.**—Constituents of Iron Alloys—Carbon—Constituents of the Iron Alloys, Carbon—Opinions and Researches on Combined Carbon—Opinions and Researches on Combined Carbon—Applying the Curves of Solution deduced from the Curves of Recalescence to the Determination of the Chemical Composition of the Carbon present in Iron Alloys—The Constituents of Iron—Iron—The Constituents of Iron Alloys—Manganese—Remaining Constituents of Iron Alloys—A Silicon—Gases. **The Chemical Composition of Slag.**—Silicate Slags—Calculating the Composition of Silicate Slags—Phosphate Slags—Oxide Slags—Appendix—Index.

EVAPORATING, CONDENSING AND COOLING APPARATUS. Explanations, Formulæ and Tables for Use in Practice. By E. HAUSBRAND, Engineer. Translated by A. C. WRIGHT, M.A. (Oxon.), B.Sc. (Lond.). With Twenty-one Illustrations and Seventy-six Tables. 400 pp. Demy 8vo. 1903. Price 10s. 6d.; India and Colonies, 11s.; Other Countries, 12s.; net.

Contents.

*Re*Coefficient of Transmission of Heat, k/, and the Mean Temperature Difference, θ/m—Parallel and Opposite Currents—Apparatus for Heating with Direct Fire—The Injection of Saturated Steam—Superheated Steam—Evaporation by Means of Hot Liquids—The Transference of Heat in General, and Transference by means of Saturated Steam in Particular—The Transference of Heat from Saturated Steam in Pipes (Coils) and Double Bottoms—Evaporation in a Vacuum—The Multiple-effect Evaporator—Multiple-effect Evaporators from which Extra Steam is Taken—The Weight of Water which must be Evaporated from 100 Kilos. of Liquor in order its Original Percentage of Dry Materials from 1-25 per cent. up to 20-70 per cent.—The Relative Proportion of the Heating Surfaces in the Elements of the Multiple Evaporator and their Actual Dimensions—The Pressure Exerted by Currents of Steam and Gas upon Floating Drops of Water—The Motion of Floating Drops of Water

upon which Press Currents of Steam—The Splashing of Evaporating Liquids—The Diameter of Pipes for Steam, Alcohol, Vapour and Air—The Diameter of Water Pipes—The Loss of Heat from Apparatus and Pipes to the Surrounding Air, and Means for Preventing the Loss—Condensers—Heating Liquids by Means of Steam—The Cooling of Liquids—The Volumes to be Exhausted from Condensers by the Air-pumps—A Few Remarks on Air-pumps and the Vacua they Produce—The Volumetric Efficiency of Air-pumps—The Volumes of Air which must be Exhausted from a Vessel in order to Reduce its Original Pressure to a Certain Lower Pressure—Index.

Dental Metallurgy.

DENTAL METALLURGY: MANUAL FOR STUDENTS AND DENTISTS. By A. B. GRIFFITHS, Ph.D. Demy 8vo. Thirty-six Illustrations. 1908. 200 pp. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Introduction—Physical Properties of the Metals—Action of Certain Agents on Metals—Alloys—Action of Oral Bacteria on Alloys—Theory and Varieties of Blowpipes—Fluxes—Furnaces and Appliances—Heat and Temperature—Gold—Mercury—Silver—Iron—Copper—Zinc—Magnesium—Cadmium—Tin—Lead—Aluminium—Antimony—Bismuth—Palladium—Platinum—Iridium—Nickel—Practical Work—Weights and Measures.

Plumbing, Decorating, Metal Work, etc., etc.

EXTERNAL PLUMBING WORK. A Treatise on Lead Work for Roofs. By JOHN W. HART, R.P.C. 180 Illustrations. 272 pp. Demy 8vo. Second Edition Revised. 1902. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Cast Sheet Lead—Milled Sheet Lead—Roof Cesspools—Socket Pipes—Drips—Gutters—Gutters (continued)—Breaks—Circular Breaks—Flats—Flats (continued)—Rolls on Flats—Roll Ends—Roll Intersections—Seam Rolls—Seam Rolls (continued)—Tack Fixings—Step Flashings—Step Flashings (continued)—Secret Gutters—Soakers—Hip and Valley Soakers—Dormer Windows—Dormer Windows (continued)—Dormer Tops—Internal Dormers—Skylights—Hips and Ridging—Hips and Ridging (continued)—Fixings for Hips and Ridging—Ornamental Ridging—Ornamental Curb Rolls—Curb Rolls—Cornices—Towers and Finials—Towers and Finials (continued)—Towers and Finials (continued)—Domes—Domes (continued)—Ornamental Lead Work—Rain Water Heads—Rain Water Heads (continued)—Rain Water Heads (continued).

HINTS TO PLUMBERS ON JOINT WIPING, PIPE BENDING AND LEAD BURNING. Third Edition, Revised and Corrected. By JOHN W. HART, R.P.C. 184 Illustrations. 313 pp. Demy 8vo. 1901. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Pipe Bending—Pipe Bending (continued)—Pipe Bending (continued)—Square Pipe Bendings—Half-circular Elbows—Curved Bends on Square Pipe—Bossed Bends—Curved Plinth Bends—Rain-water Shoes on Square Pipe—Curved and Angle Bends—Square Pipe Fixings—Joint-wiping—Substitutes for Wiped Joints—Preparing Wiped Joints—Joint Fixings—Plumbing Irons—Joint Fixings—Use of "Touch" in Soldering—Underhand Joints—Blown and Copper Bit Joints—Branch Joints—Branch Joints (continued)—Block Joints—Block Joints (continued)—Block Fixings—Astragal Joints—Pipe Fixings—Large Branch Joints—Large Underhand Joints—Solders—Autogenous Soldering or Lead Burning—Index.

THE PRINCIPLES AND PRACTICE OF DIPPING, BURNISHING, LACQUERING AND BRONZING BRASS WARE. By W. NORMAN BROWN. 35 pp. Crown 8vo. 1900. Price 2s.; Abroad, 2s. 6d.; strictly net.

WORKSHOP WRINKLES for Decorators, Painters, Paper-hangers and Others. By W. N. BROWN. Crown 8vo. 128 pp. 1901. Price 2s. 6d.; Abroad, 3s.; strictly net.

HOUSE DECORATING AND PAINTING. By W. NORMAN BROWN. Eighty-eight Illustrations. 150 pp. Crown 8vo. 1900. Price 3s. 6d.; India and Colonies, 4s.; Other Countries, 4s. 6d.; strictly net.

A HISTORY OF DECORATIVE ART. By W. NORMAN BROWN. Thirty-nine Illustrations. 96 pp. Crown 8vo. 1900. Price 2s. 6d.; Abroad, 3s.; strictly net.

A HANDBOOK ON JAPANNING AND ENAMELLING FOR CYCLES, BEDSTEADS, TINWARE, ETC. By WILLIAM NORMAN BROWN. 52 pp. and Illustrations. Crown 8vo. 1901. Price 2s.; Abroad, 2s. 6d.; net.

THE PRINCIPLES OF HOT WATER SUPPLY. By JOHN W. HART, R.P.C. With 129 Illustrations. 1900. 177 pp., demy 8vo. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; strictly net.

Contents.

Water Circulation—The Tank System—Pipes and Joints—The Cylinder System—Boilers for the Cylinder System—The Cylinder System—The Combined Tank and Cylinder System—Combined Independent and Kitchen Boiler—Combined Cylinder and Tank System with Duplicate Boilers—Indirect Heating and Boiler Explosions—Pipe Boilers—Safety Valves—Safety Valves—The American System—Heating Water by Steam—Steam Kettles and Jets—Heating Power of Steam—Covering for Hot Water Pipes—Index.

Brewing and Botanical.

HOPS IN THEIR BOTANICAL, AGRICULTURAL AND TECHNICAL ASPECT, AND AS AN ARTICLE OF COMMERCE. By EMMANUEL GROSS, Professor at the Higher Agricultural College, Tetschen-Liebwerd. Translated from the German. Seventy-eight Illustrations. 1900. 340 pp. Demy 8vo. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; strictly net.

Contents.

HISTORY OF THE HOP—THE HOP PLANT—Introductory—The Roots—The Stem—and Leaves—Inflorescence and Flower: Inflorescence and Flower of the Male Hop; Inflorescence and Flower of the Female Hop—The Fruit and its Glandular Structure: The Fruit and Seed—Propagation and Selection of the Hop—Varieties of the Hop: (*a*) Red Hops; (*b*) Green Hops; (*c*) Pale Green Hops—Classification according to the Period of Ripening: Early August Hops; Medium Early Hops; Late Hops—Injuries to Growth—Leaves Turning Yellow, Summer or Sunbrand, Cones Dropping Off, Honey Dew, Damage from Wind, Hail and Rain; Vegetable Enemies of the Hop: Animal Enemies of the Hop—Beneficial Insects on Hops—CULTIVATION—The Requirements of the Hop in Respect of Climate, Soil and Situation: Climate; Soil; Situation—Selection of Variety and Cuttings—Planting a Hop Garden: Drainage; Preparing the Ground; Marking-out for Planting; Planting; Cultivation and Cropping of the Hop Garden in the First Year—Work to be Performed Annually in the Hop Garden: Working the Ground; Cutting; The Non-cutting System; The Proper Performance of the Operation of Cutting: Method of Cutting: Close Cutting, Ordinary Cutting, The Long Cut, The Topping Cut; Proper Season for Cutting: Autumn Cutting, Spring Cutting; Manuring; Training the Hop Plant: Poled Gardens, Frame Training; Principal Types of Frames; Pruning, Cropping, Topping, and Leaf Stripping the Hop Plant; Picking, Drying and Bagging—Principal and Subsidiary Utilisation of Hops and Hop Gardens—Life of a Hop Garden; Subsequent Cropping—Cost of Production, Yield and Selling Prices.

Preservation and Storage—Physical and Chemical Structure of the Hop Cone—Judging the Value of Hops.

Statistics of Production—The Hop Trade—Index.

Timber and Wood Waste.

TIMBER: A Comprehensive Study of Wood in all its Aspects (Commercial and Botanical), showing the Different Applications and Uses of Timber in Various Trades, etc. Translated from the French of PAUL CHARPENTIER. Royal 8vo. 437 pp. 178 Illustrations. 1902. Price 12s. 6d.; India and Colonies, 13s. 6d.; Other Countries, 15s.; net.

Contents.

Physical and Chemical Properties of Timber—Composition of the Vegetable Bodies—Chief Elements—M. Fremy's Researches—Elementary Organs of Plants and especially of Forests—Different Parts of Wood Anatomically and Chemically Considered—General Properties of Wood—**Description of the Different Kinds of Wood**—Principal Essences with Caducous Leaves—Coniferous Resinous Trees—**Division of the Useful Varieties of Timber in the Different Countries of the Globe**—European Timber—African Timber—Asiatic Timber—American Timber—Timber of Oceania—**Forests**—General Notes as to Forests; their Influence—Opinions as to Sylviculture—Improvement of Forests—Unwooding and Rewooding—Preservation of Forests—Exploitation of Forests—Damage caused to Forests—Different Alterations—**The Preservation of Timber**—Generalities—Causes and Progress of Deterioration—History of Different Proposed Processes—Dessication—Superficial Carbonisation of Timber—Processes by Immersion—Generalities as to Antiseptics Employed—Injection Processes in Closed Vessels—The Boucherie System, Based upon the Displacement of the Sap—Processes for Making Timber Uninflammable—**Applications of Timber**—Generalities—Working Timber—Paving—Timber for Mines—Railway Traverses—Accessory Products—Gums—Works of M. Fremy—Resins—Barks—Tan—Application of Cork—The Application of Wood to Art and Dyeing—Different Applications of Wood—Hard Wood—Distillation of Wood—Pyroligneous Acid—Oil of Wood—Distillation of Resins—Index.

THE UTILISATION OF WOOD WASTE. Translated from the German of ERNST HUBBARD. Crown 8vo. 192 pp. 1902. Fifty Illustrations. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; net.

Contents.

General Remarks on the Utilisation of Sawdust—Employment of Sawdust as Fuel, with and without Simultaneous Recovery of Charcoal and the Products of Distillation—Manufacture of Oxalic Acid from Sawdust—Process with Soda Lye; Thorn's Process; Bohlig's Process—Manufacture of Spirit (Ethyl Alcohol) from Wood Waste—Patent Dyes (Organic Sulphides, Sulphur Dyes, or Mercapto Dyes)—Artificial Wood and Plastic Compositions from Sawdust—Production of Artificial Wood Compositions for Moulded Decorations—Employment of Sawdust for Blasting Powders and Gunpowders—Employment of Sawdust for Briquettes—Employment of Sawdust in the Ceramic Industry and as an Addition to Mortar—Manufacture of Paper Pulp from Wood—Casks—Various Applications of Sawdust and Wood Refuse—Calcium Carbide—Manure—Wood Mosaic Plaques—Bottle Stoppers—Parquetry—Fire-lighters—Carborundum—The Production of Wood Wool—Bark—Index.

Building and Architecture.

THE PREVENTION OF DAMPNESS IN BUILDINGS; with Remarks on the Causes, Nature and Effects of Saline, Efflorescences and Dry-rot, for Architects, Builders, Overseers, Plasterers, Painters and House Owners. By ADOLF WILHELM KEIM. Translated from the German of the second revised Edition by M. J. SALTER, F.I.C., F.C.S. Eight Coloured Plates and Thirteen Illustrations. Crown 8vo. 115 pp. 1902. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; net.

Contents.

The Various Causes of Dampness and Decay of the Masonry of Buildings, and the Structural and Hygienic Evils of the Same—Precautionary Measures during Building against Dampness and Efflorescence—Methods of Remedying Dampness and Efflorescences in the Walls of Old Buildings—The Artificial Drying of New Houses, as well as Old Damp Dwellings, and the Theory of the Hardening of Mortar—New, Certain and Permanently Efficient Methods for Drying Old Damp Walls and Dwellings—The Cause and Origin of Dry-rot: its Injurious Effect on Health, its Destructive Action on Buildings, and its Successful Repression—Methods of Preventing Dry-rot to be Adopted During Construction—Old Methods of Preventing Dry-rot—Recent and More Efficient Remedies for Dry-rot—Index.

GLOSSARY OF TECHNICAL TERMS USED IN ARCHITECTURE, BUILDING, PLUMBING, AND THE ALLIED TRADES AND SUBJECTS. By AUGUSTINE C. PASSMORE. Demy 8vo. About 400 pp. [*In the press.*

Foods and Sweetmeats.

THE MANUFACTURE OF PRESERVED FOODS AND SWEETMEATS. By A. HAUSNER. With Twenty-eight Illustrations. Translated from the German of the third enlarged Edition. Crown 8vo. 225 pp. 1902. Price 7s. 6d.; India and Colonies, 8s.; Other Countries, 8s. 6d.; net.

Contents.

The Manufacture of Conserves—Introduction—The Causes of the Putrefaction of Food—The Chemical Composition of Foods—The Products of Decomposition—The Causes of Fermentation and Putrefaction—Preservative Bodies—The Various Methods of Preserving Food—The Preservation of Animal Food—Preserving Meat by Means of Ice—The Preservation of Meat by Charcoal—Preservation of Meat by Drying—The Preservation of Meat by the Exclusion of Air—The Appert Method—Preserving Flesh by Smoking—Quick Smoking—Preserving Meat with Salt—Quick Salting by Air Pressure—Quick Salting by Liquid Pressure—Gamgee's Method of Preserving Meat—The Preservation of Eggs—Preservation of White and Yolk of Egg—Milk Preservation—Condensed Milk—The Preservation of Fat—Manufacture of Soup Tablets—Meat Biscuits—Extract of Beef—The Preservation of Vegetable Foods in General—Compressing Vegetables—Preservation of Vegetables by Appert's Method—The Preservation of Fruit—Preservation of Fruit by Storage—The Preservation of Fruit by Drying—Drying Fruit by Artificial Heat—Roasting Fruit—The Preservation of Fruit with Sugar—Boiled Preserved Fruit—The Preservation of Fruit in Spirit, Acetic Acid or Glycerine—Preservation of Fruit without Boiling—Jam Manufacture—The Manufacture of Fruit Jellies—The Making of Gelatine Jellies—The Manufacture of "Sulzen"—The Preservation of Fermented Beverages—**The Manufacture of Candies**—Introduction—The Manufacture of Candied Fruit—The Manufacture of Boiled Sugar and Caramel—The Candying of Fruit—Caramelised Fruit—The Manufacture of Sugar Sticks, or Barley Sugar—Bonbon Making—Fruit Drops—The Manufacture of Dragées—The Machinery and Appliances used in Candy Manufacture—Dyeing Candies and Bonbons—Essential Oils used in Candy Making—Fruit Essences—The Manufacture of Filled Bonbons, Liqueur Bonbons and Stamped Lozenges—Recipes for Jams and Jellies—Recipes for Bonbon Making—Dragées—Appendix—Index.

Dyeing Fancy Goods.

THE ART OF DYEING AND STAINING MARBLE, ARTIFICIAL STONE, BONE, HORN, IVORY AND WOOD, AND OF IMITATING ALL SORTS OF WOOD. A Practical Handbook for the Use of Joiners, Turners, Manufacturers of Fancy Goods, Stick and Umbrella Makers, Comb Makers, etc. Translated from the German of D. H. SOXHLET, Technical Chemist. Crown 8vo. 168 pp. 1902. Price 5s.; India and Colonies, 5s. 6d.; Other Countries, 6s.; net.

Contents.

Mordants and Stains — Natural Dyes—Artificial Pigments—Coal Tar Dyes — Staining Marble and Artificial Stone—Dyeing, Bleaching and Imitation of Bone, Horn and Ivory—Imitation of Tortoiseshell for Combs: Yellows, Dyeing Nuts—Ivory—Wood Dyeing—Imitation of Mahogany: Dark Walnut, Oak, Birch-Bark, Elder-Marquetry, Walnut, Walnut-Marquetry, Mahogany, Spanish Mahogany, Palisander and Rose Wood, Tortoiseshell, Oak, Ebony, Pear Tree—Black Dyeing Processes with Penetrating Colours—Varnishes and Polishes: English Furniture Polish, Vienna Furniture Polish, Amber Varnish, Copal Varnish, Composition for Preserving Furniture—Index.

Lithography and Engraving.

PRACTICAL LITHOGRAPHY. By JOSEPH KIRKBRIDE. Demy 8vo. With Plates and Illustrations. [*In the press.*

Contents.

Stones—Transfer Inks—Transfer Papers—Transfer Printing—Litho Press—Press Work—Machine Printing—Colour Printing—Substitutes for Lithographic Stones—Tin Plate Printing and Decoration—Photo-Lithography.

ENGRAVING FOR ILLUSTRATION. HISTORICAL AND PRACTICAL NOTES. By J. KIRKBRIDE. 72 pp. Two Plates and Illustrations. Crown 8vo. Price 2s. 6d.; Abroad, 3s.; strictly net.

Contents.

Its Inception—Wood Engraving—Metal Engraving—Engraving in England—Etching—Mezzotint—Photo-Process Engraving—The Engraver's Task—Appreciative Criticism—Index.

Bookbinding.

PRACTICAL BOOKBINDING. By PAUL ADAM. Translated from the German. Demy 8vo. With 129 Illustrations. [*In the press.*

Contents.

Materials for Sewing and Pasting—Materials for Covering the Book—Materials for Decorating and Finishing — Tools—General Preparatory Work — Sewing — Forwarding, Cutting, Rounding and Backing—Forwarding, Decoration of Edges and Headbanding—Boarding—Preparing the Cover—Work with the Blocking Press—Treatment of Sewn Books, Fastening in Covers, and Finishing Off—Handtooling and Other Decoration—Account Books—School Books, Mounting Maps, Drawings, etc.—Index.

Sugar Refining.

THE TECHNOLOGY OF SUGAR: Practical Treatise on the Modern Methods of Manufacture of Sugar from the Sugar Cane and Sugar Beet. By JOHN GEDDES MCINTOSH. Demy 8vo. 83 Illustrations. [*In the press.*

Contents.

Chemistry of Sucrose, Lactose, Maltose, Glucose, Invert Sugar, etc.—Purchase and Analysis of Beets—Treatment of Beets—Diffusion—Filtration—Concentration—Evaporation—**Sugar Cane:** Cultivation—Milling—Diffusion—Sugar Refining—Analysis of Raw Sugars—Chemistry of Molasses, etc.

New Textile Books.

(*See also pp.* 19-24.)

TEXTILE CALCULATIONS, especially relating to Woollens. From the German of N. REISER. Thirty-four Illustrations. Tables. [*In the press.*

Contents.

Calculating the Raw Material—Proportion of Different Grades of Wool to Furnish a Mixture at a Given Price—Quantity to Produce a Given Length—Yarn Calculations—Yarn Number—Working Calculations—Calculating the Reed Count—Cost of Weaving, etc.

WATERPROOFING FABRICS AND MATERIALS. By Dr. S. MICRZINSKI. Twenty-nine Illustrations. [*In the press.*

Contents.

Preparing the Fabrics—Impregnating the Fabrics—Drying—Paraffin—Cupric Oxide o Ammonia—Size—Tannin—Metallic Oxides, etc.

SCOTT, GREENWOOD & Co. will forward any of the above Books, *post free*, upon receipt of remittance at the published price, or they can be obtained through all Booksellers.

Full List of Contents of any of the books will be sent on application, and particulars of books in the press will be sent when ready to persons sending name and address.

SCOTT, GREENWOOD & CO.,

Technical Book Publishers,

19 LUDGATE HILL, LONDON, E.C.